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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

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Comparison of the Transcribed Intergenic Regions of the Human Genome to Chimpanzee

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Abstract

The human genome is pervasively transcribed and produces a wide array of long noncoding RNAs that have been implicated in gene regulation, chromatin modification, nuclear organization, and scaffolding for functionally active protein complexes. Of particular interest in human origins is the long and very long intergenic noncoding RNAs transcribed from genomic regions outside protein coding genes. These are known as lincRNA and vlincRNA, respectively. LincRNA regions of the genome are more taxonomically restricted than protein coding segments and make logical candidates for research in genomic discontinuity. This report describes the comparative use of three different human lincRNA datasets and one vlincRNA dataset to the chimpanzee genome using the BLASTN algorithm. Short human lincRNA genomic regions (less than 600 bases) were about 75–79% similar to chimpanzee, while the larger lincRNA regions (greater than 600 bases) were about 71 to 74% similar. The human vlincRNA genomic regions were only 67% similar to chimpanzee. In contrast, all known human protein coding exons 300 to 599 bases in length, are 86% similar to chimpanzee.

Introduction

The human genome of about 3 billion bases is an incredible storehouse of complex genetic information. The most recent estimate of protein coding sequences indicates about 28,000 to 31,000 genes (Wijaya et al., 2013), which comprises less than 5% of the total genomic sequence if just the coding exons are considered. Despite the proportionally small amount of protein coding sequence, the genome is ubiquitously copied (transcribed) into RNA. In fact, the initial report of the ENCODE project listed this phenomenon as their number one finding and stated, "First, our studies provide convincing evidence that the genome is pervasively transcribed, such that the majority of its bases can be found in primary transcripts, including non-protein-coding transcripts, and those that extensively overlap one another" (Birney et al., 2007, p. 799).

More recent research using a variety of new technologies has provided evidence of pervasive transcription for at

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least 84 to 93% of the human genome (Clark et al., 2011; Djebali et al., 2012). This high level of transcription initiates and/or occurs outside the boundaries of known protein coding exons and, when first characterized, was initially labeled the "dark matter of the genome" because of its relatively uncharacterized and mysterious nature (Johnson et al., 2005). This expressed genomic dark matter is now commonly and broadly referred to as noncoding RNA and has been shown to encode a wide variety of functional sequence categories that are generally divided into short and long noncoding RNAs (Kapranov and St Laurent, 2012; Clark et al., 2013; Geisler and Coller, 2013).

Long noncoding RNAs (lncRNA) are generally defined as non-protein-coding regions whose transcripts are longer than 200 bases (Rinn and Chang, 2012; Geisler and Coller, 2013). These lncRNAs are transcribed from intergenic regions, introns within genes, and also include anti-sense transcripts that partially overlap protein-coding genes (Rinn and Chang, 2012; Geisler and Coller, 2013). The major emerging role of many lncRNAs is that they combine with a diversity of proteins to form extensive networks of nuclear complexes that target, recruit, and help position various enzymatic activities to specific addresses across the genome (Khalil et al., 2009; Rinn and Chang, 2012; Mercer and Mattick, 2013). Such activities would include chromatin modification to either facilitate or repress transcription. On a broader genomic level, lncRNAs are also proving to be key players in DNA repair, chromosomal positioning in the nucleus, and overall genome stability and function (Ohsawa et al., 2013). Amazingly, research is also revealing that the expressed lncRNAs that act in organizing and modifying chromatin are themselves epigenetically modified to facilitate this activity through cytosine methylation of transcripts (Squires et al., 2012; Amort et al., 2013).

Some lncRNAs are also emerging, not only as repressors of gene activity but also as key players in initiating gene activity and transcription (Krishnan and Mishra, 2013). A related field of research is showing that lncRNAs can also play a wide variety of roles in posttranscriptional gene regulation (Yoon et al., 2013). One aspect in this regard involves stabilizing and promoting translation of mRNAs via base pairing. Another posttranscriptional role played by some lncRNAs is in modulating gene expression by acting as decoys for RNA binding proteins and microRNAs (miRNAs).

While lncRNAs are generally categorized as noncoding, recent studies have shown that some lncRNAs can be processed into miRNAs (He et al., 2008; Jalali et al., 2012) and small open reading frames (smORFs) that encode short functional peptides (Magny et al., 2013). In fact, the association of a subset of lncRNAs with ribosomes has been verified in several studies (Ingolia et al., 2011; Chew et al., 2013). Thus, there is strong evidence emerging that a subset of lncRNA regions has a multitranscriptional output where their products get incorporated into diverse regulatory mechanisms (Yoon et al., 2013).

In regard to cellular location, there is about a twofold enrichment for lncRNAs in the nucleus compared to the cytoplasm (Derrien et al., 2012). Of course, this begs the question as to what these large numbers of lncRNAs are doing in the cytoplasm. This remains largely unknown at this point, but once elucidated it will undoubtedly advance the number of subcategories that exist and the diverse roles they play in the cell.

Characteristics of lincRNAs

A subset of lncRNAs includes those found in regions completely outside protein-coding genes and known as long intergenic noncoding RNA (lincRNA). Like the other types of lncRNAs, they share many regulatory features and characteristics of protein-coding genes. These genelike features include (1) their functioning as discrete transcriptional units with intron-exon boundaries, (2) alternative transcription start sites, (3) five prime capping and three prime polyadenylation of transcripts, (4) alternative exon splicing during transcript processing, (5) genelike promoters and regulatory elements that include the binding of a wide array of known transcription factors, (6) histone marks associated with actively expressed genes, (7) the ability to be posttranscriptionally modulated by miRNAs and to produce back-spliced exonic circular RNAs to titrate miRNA levels (described below), and (8) functional specificity in diverse cellular processes, contexts, tissues, developmental states, and cell lines (Guttman et al., 2009; Loewer et al., 2010; Cabili et al., 2011; Guttman et al., 2011; Ulitsky et al., 2011; Derrien et al., 2012; Geisler and Coller, 2013; Jalali et al., 2013; Krishnan and Mishra, 2013; Memczak et al., 2013; Paraskevopoulou et al., 2013; Ulitsky and Bartel, 2013). Another key factor highlighting the importance of lincRNAs to human health is the fact that about 50% of all human disease-related single nucleotide polymorphisms (SNPs) are located within intergenic regions (Hindorff et al., 2009).

So what are the key regulatory differences between lincRNA genes and protein-coding genes? First, there are an estimated twofold greater number of lincRNA genes compared to protein-coding sequences (Managadze et al., 2013). Although most lincRNA genes produce polyadenylated transcripts like protein-coding mRNAs, a small fraction of them contain alternative and novel three-prime topologies (Ulitsky and Bartel, 2013). The lincRNA genes also produce far fewer circular RNA transcripts derived from backspliced exons (Memczak et al., 2013). Circular RNAs composed of exons act as miRNA sponges in the cytoplasm, titrating miRNA levels and modulating their binding activity to mRNAs. The lncRNAs, including lincRNAs, have also been implicated in being controlled by miRNAs as well as acting as miRNA decoys for the transcripts of protein-coding genes (Alaei-Mahabadi and Larsson, 2013; Jalali et al., 2013; Paraskevopoulou et al., 2013).

Yet another difference is that lincRNAs generally have fewer exons (2 to 3 on average) and their exons are longer, usually due to longer first and last exons (Derrien et al., 2012; Ulitsky and Bartel, 2013) compared to protein-coding genes that on average have about 10.7 exons (Cabili et al., 2011). The expression levels of different lincRNA genes vary widely, but the median activity is generally about one-tenth of protein-coding genes (Sigova et al., 2013; Ulitsky and Bartel, 2013). The regions encompassing lincRNA genes, including their transcripts, tend to contain larger amounts of transposable element sequence and repeats—a fact that also coincides with the knowledge that lincRNAs tolerate more variability than protein-coding genes (Ulitsky and Bartel, 2013). Finally, the expression of lincRNA genes tends to be more variable between cellular processes, contexts, tissues, developmental states, and cell lines than protein-coding genes, which indicates higher levels of transcriptional specificity (Guttman et al., 2011; Managadze et al., 2013; Sigova et al., 2013; Ulitsky and Bartel, 2013).

lincRNAs Are Taxonomically Restricted

Of greatest importance to the issue of human origins and the idea of universal common ancestry in general is that lincRNAs make logical substrates to test models of common ancestry for the following reasons. Despite their many critical functional roles, evolutionists are forced to believe that lincRNAs evolved far more rapidly than protein-coding mRNAs based on their much lower levels of sequence conservation compared to protein-coding genes (Marques and Ponting, 2009; Ulitsky and Bartel, 2013; Necsulea et al., 2014; Washietl et al., 2014). For example, less than 6% of zebrafish lincRNAs have any detectable DNA sequence similarity with human or mouse lincRNAs (Ulitsky et al., 2011). Even within closely related taxa, such as rodents, only ~50% of the mouse lincRNAs (expressed in liver) have alignable counterparts in rat—compared to ~90% of protein-coding mRNAs (Kutter et al., 2012). When Managadze et al. (2013) recently compared a 53,649 human lincRNA dataset to a mouse data set of 43,638 lincRNAs, there was shared homology for only 32% of the dataset's transcripts (100 bases of overlap was required as a threshold to denote a set of transcripts as orthologous between taxa).

Differences between human and chimpanzee long noncoding RNAs were originally most notably characterized in what was termed "human accelerated regions" (HAR). These comprised several hundred regions over 100 bases in length that contained high levels of putative substitutions, but the areas only represented highly homologous sequences that were at least 96% identical (Pollard et al., 2006a; Pollard et al., 2006b). Even with these small differences, however, it was discovered that the secondary structures produced in these noncoding RNAs were markedly different between humans and chimpanzees (Beniaminov et al., 2008).

In an early study using high-throughout genomics, expression patterns of both protein-coding genes and intergenic regions were compared between humans and chimpanzees using human microarrays, which by nature excluded the hybridization of chimpanzee sequences not highly homologous to human (Khaitovich et al., 2006). Nevertheless, they found that about 50% of the homologous expressed sequences in brain, heart, testis, and lymphoblastoid cell lines that contributed to differences between humans and chimps were intergenic noncoding RNAs—emphasizing their equal importance in contributing to taxonomic expression differences (compared to protein-coding genes).

In another study, the brain transcriptomes were compared between human, chimpanzee, and macaque, using an early variant of RNA-seq technology that produced very short reads of only ~36 bases (Xu et al., 2010). While the researchers discovered that approximately 40 to 48% of expressed brain sequences in humans originated from intronic and intergenic regions, very little information was provided as to the exact amount of differences in numbers of unique transcripts that existed between humans and chimps. The repetitive nature of these short reads rich in transposable element features likely prohibited their effective assembly into discrete transcripts. However, the researchers were able to compare the expression patterns of homologous sequences, omitting the taxonomically restricted transcripts. For these homologous transcripts among humans and apes, they found that the intergenic regions were largely conserved in their brain expression patterns across taxa, but less so than protein-coding regions.

More recently, several reports have compared lncRNA expression in a wide variety of tissues between humans, primates, and other mammals of which lincRNAs were a subset group. In one study, it was found that only 47% of expressed human lncRNAs were conserved across primates (chimpanzees, gorillas, orangutans, macaques) and only 28% were found to have homologs across non-marsupial mammals—i.e., eutherians (Necsulea et al., 2014). The results led the authors to state that "lncRNA transcription evolves rapidly," reflecting their evolutionary assumption of common ancestry. Yet another interesting result of the study was that the promoter regions of lncRNA genes preferentially bound over twice as often to homeobox transcription factors than protein-coding genes. Homeobox transcription factors are key regulators functioning in development.

In the other recent study, expression of 1,898 human lincRNAs was evaluated in human, chimpanzee, macaque, cow, mouse, and rat (Washietl et al., 2014). For three of the tissues, they could only "find orthologous transcripts for 80% in chimpanzee, 63% in rhesus, 39% in cow, 38% in mouse and 35% in rat." They also state, "Remarkably, we find that approximately 20% of human lincRNAs are not expressed beyond chimpanzee and are undetectable even in rhesus." Compared to protein-coding genes, they also claim that these human lincRNAs are "faster-evolving within the human lineage," meaning that much of the lincRNA sequence appears suddenly with no evolutionary history in apes. Both the hypothesized rapid divergence of these functional sequences and the sudden "appearance" of lincRNA genes in separate lineages are intractable problems for the evolutionary paradigm.

While a variety of reports have illustrated the differences in lincRNA expression for limited sets of transcripts between humans and chimpanzees in various tissues, none have actually compared the lincRNA genomic regions in humans from which they are derived. At the time of this report, no comprehensive comparison of the transcribed intergenic regions of the human genome compared to chimpanzee, the alleged closest living relative to humans, exists. This is despite the fact that several studies have been recently completed in humans extensively characterizing these regions. In one report, researchers used RNA-seq technology to compile a catalog of over 8,000 human lincRNAs derived from 24 different cell lines and tissue types that were strikingly tissue specific in their expression patterns, compared to protein-coding genes (Cabili et al., 2011). Data produced in this study form the bulk of sequences available at the Broad Institute lincRNA catalog (broadinstitute.org). In a more recent study, researchers compiled an even larger list of more than 58,000 human lincRNAs that included sequences derived from many novel intergenic regions of the human genome expressed at very low levels and were thus missed in previous studies (Hangauer et al., 2013). In addition, at the UCSC genome browser, a compiled set of about 22,000 lincRNAs entries exist for version hg19 of the human genome.

Interestingly, a novel study on human intergenic expressed sequences was recently published in which the researchers characterized a class of "very long intergenic noncoding RNAs," which they termed vlincRNA (St Laurent et al., 2013). In this new study, 2,147 different vlincRNAs were discovered, sequenced, and assembled. These vlincRNAs only overlap with lincRNAs by about 10% and form a completely novel class of intergenic sequence estimated to cover about 10% of the entire human genome. The vlincRNAs are much longer than protein-coding genes and standard lincRNAs and are believed to play key roles in chromatin remodeling and nuclear architecture related to gene expression. When the vlincRNAs were evaluated in a variety of cell types, they were found to be associated with cell identity, developmental states, and cancer, thus illustrating their importance to human cell and tissue development and overall health.

Given the high level of importance that the transcribed intergenic regions of the human genome play in virtually all types of cells and tissues studied to date, combined with the high levels of taxonomically restricted expression patterns they exhibit (compared to protein-coding genes), they were chosen as targets for a comparative study with the chimpanzee genome. This was done to further clarify and define the issue of human-chimp DNA sequence similarity in the human origins debate.

Methods

The four different sources used to develop query datasets are as follows: the human lincRNA catalog at the Broad Institute of MIT and Harvard (broadinstitute.org/genome_bio/human_lincrnas/?q=lincRNA_catalog) which contained 14,402 entries and largely corresponds to the study published by Cabili et al. (2011), the complete lincRNA data set from Hangauer et al. (2013) containing 58,537 sequences, the UCSC lincRNA gene tracks (downloaded Dec., 2013), and the vlincRNA dataset from St Laurent III et al. (2013). Oddly, the 2013 dataset from Hangauer et al. was based on the hg18 version of the human genome last updated in 2006, while the other data sets used hg19 (the most recent version). All data sets except for the UCSC lincRNA tracts (which were downloaded using the UCSC table browser), were each originally obtained in BED file format as indicated in their respective publications or database sites, which included genome coordinates for each sequence. Perl scripts I had written extracted the genomic sequence for each coordinate from the UCSC genome browser en masse, corresponding to whatever version of the human genome was used to originally set the coordinates (hg18 or hg19), saving them as FASTA format files with header lines for each sequence containing the corresponding BED file data. Genomic sequences were also parsed into new FASTA files based on individual sequence lengths using a Perl script I had written for the purpose of creating optimized BLASTN datasets.

Human protein-coding exons from all chromosomes, 300 to 599 bases in length, were downloaded from the hg19 version of the human genome at ucsc.genome.edu, using appropriate parameters in the table browser feature. These were obtained in FASTA format and queried against the chimpanzee genome and the human genome as a comparative control using the BLASTN parameters described below.

The lincRNA regions less than 300 bases in length provided unreliable BLAST results when compared against the human genome as a control and were thus omitted from the analyses. The lincRNA regions between 300 and 599 bases in length were used directly for BLASTN analyses, while lincRNA and vlincRNA regions 600 bases and longer were subjected to sequence slicing using a Python script I had written and described previously (Tomkins, 2013). Basic statistical analyses for the genomic sequences in the human lincRNA and vlincRNA query sets were done using a Perl script I had written creating the data shown in Table I.

The most recent versions of the chimpanzee (CHIMP2.1.4.71), and the human genomes (GRCh37.71/hg19) were downloaded from ftp.ensembl.org/pub. Human genome version hg18, for control testing of the Hangauer et al. linc hg18 annotated lincRNA dataset was downloaded from hgdownload.soe.ucsc.genome.edu. The various genome assemblies were then used to make individual BLAST databases using the makeblastdb tool. Batch BLASTN jobs were deployed on UNIX and Linux servers as described previously (Tomkins, 2013). BLASTN results were outputted as CSV format text files and parsed and analyzed via an integrated set of Python and POSIX shell scripts I had written. BLASTN algorithm parameters were as follows: -word_size 11, -evalue 10, -max_target_seqs 1, -dust no, -soft_masking false, -ungapped. These optimized parameters were chosen largely on the results of Tomkins (2011) and Tomkins (2013) and also preliminary analyses performed in this study.

Results

Four different long intergenic noncoding DNA data sets were used for this project: (1) the human lincRNA catalog at the Broad Institute of MIT (broadinstitute.org/genome_bio/human_lincrnas/?q=lincRNA_catalog), which contained 14,402 entries and largely corresponds to the study published by Cabili et al. (2011); (2) the complete lincRNA data set from Hangauer et al. (2013) that was demarcated based on the coordinates of human genome version hg18 and comprises 58,537 sequences; (3) the lincRNA entries at the UCSC genome browser for version hg19 of the human genome; and (4) the vlincRNA dataset from St Laurent III et al. (2013). The MIT and St Laurent III et al. datasets were also based on hg19 version of the human genome. Sequence statistics for each of these datasets can be viewed in Table I. Individual entries in each dataset were composed of the entire contiguous lincRNA or vlincRNA genomic region minus the promoter. All genomic data was downloaded from the UCSC genome browser using the BED file genome coordinates provided in the supplementary information of each published paper or listed on the respective databases (see Methods section for details).

As a comparative reference for the lincRNA and vlincRNA regions, all human protein coding exons between 300 and 599 bases in length also were utilized via extraction from the UCSC genome table browser (version hg19). The protein-coding exons of the human genome are arguably the most similar in sequence identity to chimpanzee, whose alignable regions have been selectively used by evolutionists in a wide variety of comparative studies (Tomkins and Bergman, 2012).

In regard to comparing lincRNA sequence between taxa, the following problem was recently noted in a review by Ulitsky and Bartel (2013), in which they stated, “Existing approaches for comparing genomic sequences, which rely heavily on stretches of high sequence conservation, might be poorly suited for detecting homology between lincRNAs” (pp 34–35). Previous research using a wide variety of BLASTN algorithm parameters showed that alignments of human-chimpanzee genomic DNA broke down significantly after only several hundred bases on average, terminating the extension of the algorithm (Tomkins, 2011). To overcome this limitation, Tomkins (2013) devised a strategy of sequence slicing to produce multiple datasets comprised of differ-

Table I. Sequence characteristics of the human lincRNA and vlincRNA genomic regions for each data set used in this study.

Data set source	Type of intergenic sequence	Number of sequences	Mean length (bases)	Median length (bases)	Minimum length (bases)	Maximum length (bases)
Cabili et al./MIT (2011)	lincRNA	14,402	15,403	5,363	256	603,040
UCSC hg19 (Dec 8, 2013)	lincRNA	21,629	19,117	6672	256	690,433
Hangauer et al. (2013)	lincRNA	58,537	1,788	511	202	373,456
St Laurent III et al. (2013)	vlincRNA	2,762	130,566	83,866	50,002	1,104,100

ent slice sizes representing the original contiguous sequence. Each set of slices is then BLASTed against the target database and the optimal output of multiple experiments is selected as an accurate indicator of overall sequence similarity. This strategy effectively overcomes the limitations imposed by large insertions and deletions that disrupt pairwise BLASTN comparisons across large genomic regions. In addition, this strategy also overcomes lack of synteny (linear order of genomic features) for alleged rearrangements of sequence. This strategy was used successfully to determine the overall sequence similarity for individual chromosomes in the chimpanzee genome compared to their homologous human counterparts (Tomkins, 2013).

Preliminary studies with all lincRNA datasets showed that sequences between 300 and 599 bases in length could be effectively aligned without sequence slicing (data not shown). The lincRNA regions more than 600 bases in length were treated as a single large genomic file and sliced into a range of sub files. The most recent version of the chimpanzee genome downloaded from Ensembl.org (CHIMP2.1.4.71) was used as the target database. To evaluate the amount of sequence that may have been lost in the process of concatenating and slicing, query sets were also BLASTed against the version of the human genome from which they were derived (hg18 or hg19). The amount of sequence lost as a caveat of concatenation and slicing was minimal, (0.0 to 1.3%) and was factored back into the similarity estimates achieved.

Basic sequence statistics for each data set are listed in Table I. The human lincRNA genomic regions from the MIT and UCSC datasets were heavily enriched for larger transcripts—only about 3% were less than 600 bases in length. In contrast, the more extensive lincRNA data set of 58,537 genomic sequences from Hangauer et al. (2013) was heavily enriched for regions of the genome encoding shorter transcripts, and 57% of the sequences were less than 600 bases. The Hangauer et al. data purportedly also represents a large number of newly characterized transcripts expressed at very low levels in the cell.

The shorter lincRNA regions of the human genome (300 to 599 bases) were 75 to 79% similar to chimpanzee, depending on the dataset (Table II). Given that slightly over half of the Hangauer et al. dataset consisted of lincRNA regions less than 600 bases, the best estimate of short lincRNA region similarity would probably be represented by this data. Eleven percent of the short human lincRNA regions in this data set were completely missing in the chimpanzee genome. This same percentage was also reflected in the two other data sets as well.

The larger lincRNA regions had to be subjected to optimized sequence slicing to ascertain their overall similarity to chimpanzee. The identity of the top aligning sets of slices for these experiments indicated that these longer lincRNA encoding regions of the human genome are only 71 to 74% identical chimpanzee (Table II). Clearly, the longer types of human lincRNA regions of the genome are slightly less similar to chimpanzee than the shorter segments.

For the vlincRNA dataset representing the regions of the human genome transcribed into very long noncoding RNAs (50,000 and 1,104,100 bases in length), the DNA sequence identity compared to chimpanzee was only 67% for the optimal aligning set of subsequences. Much of the dissimilarity was due to large segments of the vlincRNA genes present in human and missing in

Table II. BLASTN results for each data set using the chimpanzee genome (Ensembl ver chimpv2.1.4.71).

Data set source	Type of intergenic sequence	Sequence identity	Optimal sequence slice and range tested (bases)*
Cabili et al. (2011)/MIT	lincRNA 300-599 bases	75.3%	---
UCSC hg19 (Dec 8, 2013)	lincRNA 300-599 bases	75.5%	---
Hangauer et al. (2013)	lincRNA 300-599 bases	78.8%	---
Cabili et al. (2011)/MIT	lincRNA 600+ bases	72.1%	250 (200-450)
UCSC hg19 (Dec 8, 2013)	lincRNA 600+ bases	71.0%	250 (200-450)
Hangauer et al. (2013)	lincRNA 600+ bases	73.9%	250 (200-400)
St Laurent III et al. (2013)	vlincRNA	67.0%	450 (250-500)
Protein coding exons	300-599 bases	86.5%	---

* Subset query files were based on 50 base increments (e.g. 200, 250, 300, etc).

chimpanzee. The optimum alignment length was 450 bases, and approximately 29% of these segments had no match in chimp. The vlincRNA regions of the human genome represent a completely separate class of intergenic expressed regions and only overlap with lincRNA regions by an estimated 10% (St Laurent et al., 2013). It is believed that their function is primarily associated with chromatin modifying scaffolds that regulate genome function and architecture.

As a comparative control, all known human protein-coding exons from version hg19 of the human genome between 300 and 599 bases in length were BLASTed against the chimpanzee genome. Overall, DNA similarity was only 86%—a number that includes the results that approximately 6.3% of human protein-coding exons in this size range are completely missing in the chimpanzee genome. The exons that did align were 91.8% identical on average. Overall, the noncoding transcribed intergenic regions of the human genome are about 7 to 19% less similar to chimpanzee than protein-coding exons. The general trend is that the shorter noncoding transcribed intergenic regions tend be more similar on average than the longer regions. The vlincRNA regions are the most dissimilar.

Summary and Discussion

For years, the standard axiom has promoted the idea that humans are 98% genetically identical to chimpanzees. However, this dogmatic statement about the DNA similarity between humans and chimps is based on cherry-picked data from short, aligned segments of high similarity and omits the regions that are vastly different. The leading human and chimpanzee DNA comparison studies published by evolutionists during the past decade were recently reviewed and critiqued (Tomkins and Bergman, 2012). In every single report, the researchers selected highly similar DNA sequence data and discarded other data because it would not readily align. In fact, when the DNA similarities from these papers were recalculated using omitted data for the alignments, markedly lower levels of similarity were found that varied between 70 and 86%. Even the rough draft of the chimpanzee genome published in 2005 provides an overall genomic similarity of only about 70 to 80% when the discarded non-similar data is included (Tomkins and Bergman, 2012; Tomkins, 2013).

Much of the reported human-chimp DNA similarity data is due in part to the inherent BLASTN algorithm restrictions associated with aligning chimpanzee genomic sequence onto human and vice versa. In a recent study, a wide variety of BLASTN algorithm parameters were tested using 40,000 740-base long segments of chimpanzee genomic DNA (preselected to be homologous to human by NCBI) that were queried against four different versions of the human genome (Tomkins, 2011). The algorithm parameter combinations that produced the longest alignments gave similarities of 86% and the algorithm stopped aligning after only a few hundred bases on average, due to extreme dissimilarity between the genomes.

The phenomenon of high levels of human-chimp genomic discontinuity was first noted by evolutionists in the initial stages of sequencing the chimpanzee genome. Researchers produced over 3 million bases of chimp genomic sequence (60 to 950 bases per read) and then BLASTed them against the human genome (Ebersberger et al., 2002). The report stated that only "About two thirds could be unambiguously aligned to DNA sequences in humans" (p. 1490). The researchers also set their BLASTN parameters to omit DNA less than 98% identical and did not report the amount of each read not aligning, just that only two-thirds of them did.

Clearly a more informative technique was required to compare the chimpanzee genome to that of humans to provide estimates of DNA similarity over long genomic distances. Specifically, a technique was needed to counteract the problem of the BLASTN algorithm breaking off the alignment extension in regions of low similarity. By digitally slicing entire chimp chromosomes into small pieces, Tomkins (2013) found that the BLASTN algorithm could effectively compare chimp DNA to human piece-by-piece by testing a range of sub-slice datasets and then selecting the highest sequence identity output. The same technique was used in this study to compare the transcribed intergenic regions of the human genome to chimpanzee.

Research is showing that the mysterious whereabouts of information underpinning organismal complexity is not entirely associated with just the basic protein-coding gene sets. Instead, much of this important information is located in the highly functional, noncoding portions of the genome; and as organismal complexity increases, so does the amount and complexity of transcribed intergenic noncoding RNA (Liu et al., 2013). The main points concerning the noncoding portions of genomes can be summarized as follows: (1) Any given human or animal genome is a complete storehouse of important information, and this fact negates the concept of "Junk DNA." (2) Protein-coding genes are largely a basic set of instructions within a complex and larger expressed repertoire of both regulatory and structural noncoding DNA sequence.

Related to these emerging concepts about noncoding DNA is the fact that the transcribed intergenic regions of the genome contain much higher levels of taxonomically restricted DNA sequence, compared to the exonic protein-coding segments (Ponjavic et al., 2007; Ulitsky et al., 2011; Managadze et al., 2013). Previous research comparing these intergenic noncoding regions of the human genome to chimpanzee is based on studies using selected tissue and cell line transcriptomic data sets. While these studies compared only a small fraction of the human intergenic transcriptomes, it was found that noncoding transcripts were significantly more taxonomically restricted than protein-coding ones (Khaitovich et al., 2006; Xu et al., 2010; Necsulea et al., 2014; Washietl et al., 2014). At present, research exhaustively comparing the regions of the human genome producing long intergenic transcripts to chimpanzee has not been done.

This report describes the comparative use of three different human lincRNA datasets and one vlincRNA genomic dataset to the chimpanzee genome using the BLASTN algorithm under parameters previously shown to provide optimal alignments (Tomkins, 2013). Short human lincRNA regions (less than 600 bases) are about 75–79% similar to chimpanzee while the larger lincRNA regions (greater than 600 bases) are about 71 to 74% similar. The human vlincRNA genomic regions are only 67% similar to chimpanzee. To provide a comparative contrast, all human protein-coding exons 300 to 599 bases in length were also queried against the chimpanzee genome, and found to be 86% similar to chimpanzee. Overall, the noncoding transcribed intergenic regions of the human genome are about 7 to 19% less similar to chimpanzee than protein-coding exons.

One point of particular interest is that the long (greater than 600 bases) lincRNA and vlinc RNA regions were markedly different, and their putative function appears to be related to large-scale chromatin modification. The implications are that significant RNA-mediated chromosomal and nuclear architecture differences between humans and chimpanzees may also be an important contributor to functional genomic differences.

The DNA similarity results from this study fit well with a previous report in which the chimpanzee chromosomes were sequentially compared to human chromosomes using the same technique of sequence slicing (Tomkins, 2013). Not counting the Y-chromosome, chimpanzee chromosome similarities compared to human varied between 66 and 78%. Overall, the chimp genome was only 70% identical on average to human. In addition, these current results also correlate well with a recent study of 1,898 human lincRNA genes expressed in a variety of tissues in which only 80% had counterparts expressed in chimp tissue (Washietl et al., 2014).

The real genome-wide differences between chimps and humans are too vast to be explained by hypothetical evolutionary processes. The regions that are similar between chimps and humans are easily interpreted as repetitions of effective design themes associated with code reuse, a concept that is very familiar to software designers and engineers. DNA sequence comparisons that include all the relevant data clearly show that the human and chimpanzee genomes are not nearly identical but instead are as different as one might expect based on the clearly observed phenotypic discontinuities.

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Analysis of Walt Brown's Model of a Pre-Flood 360-Day Year

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Abstract

Walt Brown (Brown, 2008) has proposed that the year originally was 360 days long and had twelve 30-day months. He further proposed that within his hydroplate model significant changes in the earth and moon at the time of the Flood altered the lengths of the day and month to the current configuration. Here I evaluate this claim. From the standpoint of basic physics, his mechanism of shortening the day by 1.46% is plausible, though I don't address the question of the geophysics involved. However, the mechanism for decreasing the size of the moon's orbit to shorten the month has problems. Brown's proposal of selective impacts on the leading edge of the moon as it orbited the earth is based upon a misunderstanding of orbital mechanics. There is no suitable site on the moon for the required number of impacts. Furthermore, the energy released by the many required impacts would have produced far too much heat on the moon.

Introduction

A previous paper (Faulkner, 2012) analyzed the often-heard claim among recent creationists that prior to the Flood the year consisted of twelve months, each with 30 days, for a total year length of 360 days. That paper showed that ancient documents do not support the contention that the actual length of the year ever was 360 days long. It further argued that the biblical passages that supposedly indicate a 360-day year in the past are easily understood in other ways. It also stated that no one has proposed a clear model of how such a change could have taken place to alter the supposed creation calendar to the one we have today. In a letter to the editor, Enyart (2013) showed that that statement about a lack of models was untrue, for Brown (2008) had published such a model in conjunction with his hydroplate model. In a response to this letter, I apologized for that oversight and suggested that Brown's proposal be examined (Faulkner, 2013). I endeavor here to evaluate Brown's model of how the lengths of the day and month might have readjusted because of the Flood.

Brown's Model of How the Day Changed

As stated before, in order to change the calendar as alleged, one must alter at least two of the three natural measures of time: the day, the month, and the year (Faulkner, 2012). Brown suggested changing the lengths of the day and the month, while leaving the year the same. He proposed that the length of the day was shortened by the settling of denser material toward the earth's center at

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the time of the Flood (Brown, 2008, p. 149). Like any other spinning object, the earth possesses angular momentum. For a spinning object, angular momentum, L, is given by

$$L = I\omega,$$

Where I is the moment of inertia and ω is the angular velocity. Alternately, we may express the spin angular momentum in terms of the period of rotation T, as

$$L = 2\pi I/T.$$

Absent a net torque, angular momentum is conserved. That is, the initial angular momentum, L_1, and the final angular momentum, L_2, are equal:

$$L_1 = L_2.$$

If we concern ourselves with the moments of inertia and periods at two epochs, then we can express this as

$$2\pi\, I_1/T_1 = 2\pi\, I_2/T_2,$$

which reduces to,

$$I_1/T_1 = I_2/T_2,$$

or

$$I_1/I_2 = T_1/T_2 = \text{constant},$$

where the subscripts refer to the two epochs. That is, a change in rotation period must be accompanied by a proportional change in the moment of inertia. Thus, if at the time of the Flood the earth's moment of inertia decreased, the length of the day would have decreased, and now there would be more days in the year than prior to the Flood.

The moment of inertia of a *uniform*-density sphere spinning on an axis passing through the sphere's center of mass is

$$I = 2/5\, mr^2,$$

where m is the mass and r is the radius. The earth is not a uniform sphere, but we can compute its moment of inertia by summing a series of nested uniform shells, each with mass m and having inner radius r_1 and outer radius r_2. This assumption requires that the earth be reasonably spherically symmetric, which appears to be correct. A shell has moment of inertia,

$$I = 2/5\, m\, (r_2^{\,2} - r_1^{\,2}).$$

A change in the earth's rotation so that it spins 365.246 times in a year rather than an original 360 times per year requires that the rotation period decrease by 1.46%. By conservation of angular momentum, this must be accompanied by a 1.46% decrease in the earth's moment of inertia. Brown tabulated the computation of his proposal for the pre-Flood and post-Flood earth (Brown, 2008, pp. 430–432). This shows a 1.46% decrease in the earth's moment of inertia at the time of the Flood; so from the physics of rotational motion, this is possible. I am not qualified to assess the geophysical plausibility of Brown's proposal, so I will leave that to others.

Technically, because the earth orbits the sun, one ought to include the angular momentum due to the earth's orbital motion as well. Because the situation under review involves merely the rearrangement of material in the earth, there is no transfer of angular momentum between the rotational and orbital terms. However, when one alters the momentum of inertia of an orbiting body, in the general case the orbital motion changes too. One is tempted to treat the earth as a point mass orbiting the sun. In that case, there is no change in the earth's orbital motion, as material within the earth rearranges. But is this approach warranted? I shall show that this approximation is warranted, and that the earth's orbital motion is not appreciably affected by a 1.46% change in its moment of inertia. The total angular momentum of the earth is the sum of the spin angular momentum and orbital angular momentum:

$$\mathbf{L}_{total} = \mathbf{L}_{spin} + \mathbf{L}_{orbital}.$$

Note that here I have written L in boldface, indicating that it is a vector. Letting M represent the earth's mass, **R** the radius vector, and **V** (both vectors) the orbital velocity, we can write the total angular momentum as,

$$\mathbf{L}_{total} = \mathbf{L}_{spin} + \mathbf{R} \times M\mathbf{V}.$$

I already considered the spin angular momentum case. What is the value of the orbital angular momentum? Because the earth's orbit is nearly circular, we can approximate it as a circle, in which case the orbital angular momentum becomes

$$\mathbf{L} = I\, \omega_{orbital},$$

where $\omega_{orbital}$ is the orbital angular velocity (also expressed as a vector). By the parallel axis theorem,

$$I = I_{spin} + MR^2.$$

The assumption that the earth is a uniform sphere would overestimate the value of I_{spin}, but making that assumption and using the appropriate values of the earth's mass, radius, and orbital radius, I find that the second term is 1.4×10^9 times larger than the first term. That is, treating the earth as a point mass as it orbits the sun introduces an error of about one part per billion. However, since we are merely concerned with any change that results from altering the I_{spin} term by 1.46%, the second term is 9.5×10^{10} larger than the first term. The more exact treatment of a nonuniform earth and noncircular orbit will not change this situation. At best, a 1.46% change in the earth's moment of inertia will not alter the earth's orbit by about eleven orders of magnitude. Since there are 3.15 x 10^7 seconds in a year, this would change the length of the year by at most 1/3000 second.

Brown's Model of How the Month Changed

Brown suggested that the moon's orbital period decreased at the time of the Flood by collisions with material ejected from the earth. In discussing this, Brown wrote:

> While these particles would have a wide range of orbits, the greatest concentration of debris would initially travel near to and roughly parallel with Earth's orbit. Half the time, the Moon would have traveled generally in the same direction as this dense debris, so collisions would have been few and of low velocity. During the other half of the Moon's orbit, orbiting debris would have opposed the Moon's motion; many high-velocity collisions would have removed energy from the Moon's orbit.
>
> The Moon would have been analogous to a massive truck that every 15 days traveled in the proper lane (with the flow of traffic). On alternate 15-day periods this "truck" traveled in the wrong lane (facing oncoming traffic), experienced many collisions, and lost some of its energy. (Brown, 2008, p. 421)

There are at least three problems with this. First, this scenario reveals a fundamental misunderstanding of the orbital mechanics of the moon, earth, and sun. Brown suggested that a large amount of debris was travelling "near to and roughly parallel with the earth's orbit." This required that the debris orbit the sun in orbits very similar to the earth's orbit. Otherwise, the debris would not have remained in close proximity of the earth very long. The moon travels near to and roughly parallel with the earth's orbit as well. This is easy to see by comparing the gravitational force of the sun on the moon to the earth's gravitational force on the moon. The sun's gravitational force is twice that of the earth's gravity. Consequently, the moon's orbit is at every point concave toward the sun, even as it orbits the earth. This is a subtle point that most people miss, for we tend to think in terms of the moon solely orbiting the earth. But the primary gravitational force on the moon is that of the sun, and in a very real sense the moon orbits the sun. Within the local frame of reference, the earth and moon are in free fall around the sun. Therefore, the earth, being the largest mass in the vicinity, produces the dominant local gravitational force, causing the moon to orbit it. Since Brown's proposed concentration of debris is moving along with the earth in its orbit around the sun, the debris is in free fall too, is subject to similar gravitational attraction from the earth that the moon is, and hence must orbit the earth as the moon does. Ironically, elsewhere Brown discussed this concept in the context of his "sphere of influence" (Brown, 2008, pp. 265–266). The only way that debris in Brown's proposal could avoid orbiting the earth would be if they had very different orbits than the earth did around the sun. But under this circumstance, they would rapidly depart the vicinity of the earth and moon, leaving at most one opportunity for those particles to collide with the moon. The departure time would be on the order of days, far less than the many months of collisions that Brown seems to imply. Thus, Brown's comparison to the moon moving along like a truck alternately flowing with and then opposing "traffic" is not physically possible. This is a serious flaw, because without the preferential higher-speed impacts on the moon's leading side, Brown's proposal would not work. The key to Brown's mechanism is the relative efficiency of high-speed impacts on the leading side of the moon. Since this is not possible, Brown could greatly increase the amount of debris that would collide with the moon in hopes that a somewhat less efficient mechanism of removing orbital energy from the moon could balance out the lack of efficiency. However, a much greater number of impacts would exacerbate the remaining two problems.

A second problem is that there is no evidence that the moon received a greater number of impacts on its leading side as it orbits the earth. Elsewhere Brown identified the likely impact sites as what is now the nearside of the moon (Brown, 2008, p. 280). He suggested that originally the moon did not follow synchronous rotation as it does today but before the Flood rotated slightly more rapidly than it revolved. He further suggested that the Flood-related impacts produced an oscillation and that tidal interaction eventually produced synchronous rotation. Brown identified the mascons found mostly (but not exclusively) on the nearside of the moon as the sites of early major impacts in his scenario. Synchronous rotation (rotating and revolving at the same rate) is a common feature of planetary satellites, including the moon. While this might explain the moon's synchronous rotation, it does not explain why nearly all planetary satellites in the solar system experience synchronous rotation. Furthermore, tidal locking such as this takes a long time, much longer than a biblical timeframe would allow.

The third problem is the amount of energy required to decrease the length of the month. To reduce the moon's orbital period from its supposed original state to what exists today, Brown showed that the amount of orbital energy that the moon must lose is 2% (Brown, 2008, p. 421). Orbital energy is given by,

$$E = -GmM/2a,$$

where G is the universal gravitational constant, m is the mass of the orbiting body, M is the mass of the orbited body, and a is the semimajor axis. The negative sign is the result of our choosing the reference point of the potential energy at infinity (it makes the math work out better). Putting in the appropriate numbers, the moon's orbital energy is -3.81×10^{28} J, and so a decrease of 2% orbital energy results in a loss of energy of 7.62×10^{26} J. Collisions of the type that Brown proposes are very inelastic, and we can accurately model them as totally inelastic collisions. Modeling this as totally inelastic collisions, all of the orbital energy robbed from the moon is physically absorbed by the moon. While some of this energy would go into deformation, most of it eventually would end up as heat.

Just how much heat is this? It would be helpful to determine how much rock this much heat could melt. The lunar surface consists of rocks very similar to granite and basalt. Much of the moon's interior probably is basalt. The specific heats of granite and basalt are very similar, about 800 J/Kg C. Their latent heats of fusion are similar too, about 4.2×10^5 J/Kg. The melting points vary, but a good approximation (particularly since we do not know the initial temperature) is 1200 C. Let us assume a temperature change of 1200 C, followed by melting. The equation for determining the heat involved is

$$E = cm\Delta T + mL,$$

where c is the specific heat, m is the amount of rock heated and then melted, ΔT is the temperature change, and L is the latent heat of fusion. The result is that 5.5×10^{20} Kg of rock would be melted. The density of basalt is about 2.9×10^3 kg/m^3, with granite slightly less. Assuming basaltic density, the rock heated and melted would have occupied 1.9×10^{17} m^3. Uniformly distributed over the moon, this would be a layer 5.0 km thick. However, this is a minimal figure, because this result came by considering only impacts that rob orbital energy from the moon. As Brown admits, some impact would be from behind, imparting orbital energy, though he seriously underestimated the efficiency of his mechanism (see objection one above). Other impacts would have affected the moon's orbital energy by varying degrees, both positively and negatively. All impacts, whatever the change, if any, in orbital energy, will impart heat to the moon. Even granting the unrealistic scenario of preferential impacts on the leading face of the moon, the lower velocity impacts that add orbital energy to the moon add additional heat, and these impacts must be counterbalanced by additional collisions that rob orbital energy, resulting in the net release of more heat. Thus, at best, we must multiply the thermal energy input on the moon by some factor. I will assume a very conservative number of two, increasing the depth of melted rock to 10 km. I emphasize that this is a very conservative number; if the orbits of debris that Brown proposed are properly assessed, the multiplicative factor would be far higher.

Brown likely would respond to this criticism by pointing out that the lunar maria, some of which coincide with lunar mascons, are the locations of the melted rock. The maria account for 16–17% of the lunar surface. Correcting for this, the maria would need to average about 60 km in depth to account for the amount of heat generated by the questionable scenario Brown suggests. Of course, this assumes that the maria resulted entirely from melted rock and not from any magma released upon the surface from the lunar interior. Maria depth is difficult to measure at this time, and it probably varies from one impact basin to another. However, Thomson et al. (2009) recently determined that the Imbrium Basin mare basalt is about 2 km thick. Much earlier, Baldwin (1970) found a similar maximum depth of the Oceanus Procellarum mare. If this depth is typical of the maria, then even the conservative estimate of melted material required by Brown's model is an order of magnitude greater than is found on the moon. Head and Wilson (1992) estimated the total volume of lunar maria basalts at 1×10^7 km^3 (10^{16} m^3). This, too, is an order of magnitude less than computed volume of required melted rock in Brown's model computed here (1.9×10^{17} m^3).

The above melted rock computation is very conservative, because it assumes the unrealistic model of the moon sweeping up far greater debris during one half its orbit than during the other half. However, as previously argued, this assumption ignores the fact that any debris sharing the earth and moon's orbit around the sun must orbit the earth as the moon does, so there is no preferential sweeping up of material. That is, the "truck analogy" is false. With a far more random distribution of impacts, the number of impacts required to reduce the moon's orbital energy by 2% rises to unacceptable heights, probably by another order of magnitude at least.

Conclusion

I have evaluated Brown's model for how the lengths of the day and month could have changed at the time of the Flood. While his proposal for how the day might have changed length is consistent with basic physics and hence may be possible, his suggestion of how the Flood altered the month is fraught with difficulties. There is a problem with his presentation of the orbits of debris ejected from the earth. This suggests a fundamental misunderstanding of orbital mechanics on his part, for any particles appreciably smaller than the earth co-orbiting the sun with the earth must orbit the earth, as the moon does. His identification of the lunar nearside as the site of the impact of debris that robbed the moon of orbital energy is questionable. Even if one grants Brown's unrealistic claim of preferential impacts on the moon, there is a considerable heat problem. When the orbital problem with the debris is corrected, the heat problem is far greater.

The results presented here agree with my earlier assessment (Faulkner, 2012), that models of altering the day, month, and/or year at the time of the Flood have serious physical problems. As shown in that previous paper (Faulkner, 2012), there are neither biblical nor historical reasons for believing that the original year consisted of twelve 30-day months. Hence, proposals to change the relationship between the day, month, and year at the time of the Flood are unnecessary.

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Giordano Bruno: The First Martyr of Science or the Last of the Magicians?

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Abstract

The martyrdom of the sixteenth-century philosopher and professor Giordano Bruno is widely regarded by scholars as the beginning of the war between science and religion. A review of the case documents that Bruno's difficulties were not due to his science, but rather to the clear, open theological conflicts he had with Christianity and his attitude toward authority. Bruno also experienced numerous major conflicts with professors and philosophers of his day, which did not help his case.

Introduction

To support the view that religion has historically been, and still is today, the enemy of science, writers often cite examples of persecution of scientists by the church (Russo, 1963). The beginning of such persecution is commonly alleged to have been the execution of Giordano Bruno (1548–1600), who is called "the first martyr" of science (Lerner and Gosselin, 1973, p. 86). Kerrod and Stott claimed that in 1600 Bruno was "burned at the stake for the heresy of supporting Copernicus's concept of a solar system" (Kerrod and Stott, 2007, p. 186), and Andrew D. White, in his classic 1895 work on the war between science and religion, wrote that Bruno was "murdered" by the Inquisition for his "scientific and philosophic heresy" (White, 1955, pp. 15, 143). Implying that Bruno's troubles were a result of religion-science conflicts, John W. Draper claimed that Bruno was murdered by his church's hierarchy (Draper, 1875, pp. 180–181). Lewis has two chapters in his book titled *The Struggle Between Science and Superstition* that makes similar claims (Lewis, 1915, pp. 88–127).

G. Murray McKinley concluded that Bruno was "one of the earliest modern thinkers" and that his passion for science "led Giordano Bruno to defy the authority of his day" (McKinley, 1956, pp. 56, 234). Ben Smith bluntly stated, "Giordano Bruno was burned at the stake because his scientific philosophy did not conform to the teachings of the Church" (Smith, 1959, p. 48), and John H. Randall described Bruno as "the great martyr of the new science ... a man whose soul was set on fire by the Copernican discoveries ... [eventually] to fall at last a victim to the Inquisition and die in flames in Rome" (Randall, 1976, p. 242). Kessler wrote that he is "one martyr whose name should lead all of the rest" (Kessler, 1946, p. 11). Social scientist G. Q. Marwat wrote:

> Bruno was the first scientist who suffered death at the stake because of [the] tenacity with which he maintained his unorthodox ideas at a time when both the Roman Catholic and Reformed churches were reaffirming rigid Aristotelian and Scholastic principles. ... On Feb. 8, 1600, when the death sentence was

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> formally read to him, he addressed his judge by saying, "Perhaps your fear in passing judgment on me is greater than mine in receiving it." Bruno was the first martyr of science. (Marwat, 2003, p. 4)

Robert Youngson, under the subheading, "Don't Tangle with the Church," claimed Bruno was "an Italian astronomer, mathematician, and scientist whose far-seeing scientific imagination was two centuries ahead of his time" (Youngson, 1998, p. 281). He claimed that when Bruno was brought before the Inquisition they demanded that he

> retract all his scientific theories. Bruno then tried to show that these scientific beliefs were not incompatible with a Christian belief in God and creation. He believed in an intellect which animated the universe and that the visible world was a manifestation of this great intellect. This all-pervading intellect was God. These views cut no ice with the Inquisition and Bruno was repeatedly pressed to deny and retract his science. He refused. (Youngson, 1998, p. 284)

Professor Leonard Susskind, after noting that "religion and science have never loved each other for very long," concluded that the "bad times are well known" and cited "the burning of Giordano Bruno, the inquisition of Galileo, [and] Darwin's fear of being made an outcast" as examples (Susskind, 2006, p. 24). The eminent scientist Neil deGrasse Tyson stated, "I'm happy to report that they don't burn people at the stake if they claim that Earth goes around the sun, or that there are other stars that might have planets that themselves could support life. It's statements like that that got Giordano Bruno burned at the stake in 1600" (Boyle, 2006, p. 3).

Even Edward Larson, noted for his accuracy when dealing with religion-science topics, wrote that "the Church-approved answer" to religious conflicts was to silence "scientific–sounding freethinkers such as Giordano Bruno ... as Bruno was, by the Inquisition" (Larson, 2001, p. 19). Under the subtopic "People Who Gave Their Lives and Limbs to Science," Conner and Kitchen listed the number one example as Bruno, who "was burned at the stake in 1600 by the Inquisition in part for his heretical teaching throughout Europe that Earth revolved around the Sun and that there may be an infinite number of Earthlike worlds and suns" (Conner and Kitchen, 2002, p. 34). Ingrid Rowland even claimed that modern cosmology was "developed in far greater detail" by Bruno, who was "burned at the stake in Rome in 1600" for his scientific work (Rowland, 2004, p. 196). Finally, the Freethought Association called Bruno an "astronomer, philosopher, and Freethinker" (Freethought Association, 1928, p. 244). So, is the case closed? Do all the authorities agree that Bruno was a brave scientist who was persecuted and martyred because of his commitment to scientific truth?

The First Scientific Martyr

Bruno is so important to many critics of the church that his death is commonly listed as the "first scientific martyr" and an "example of the inevitable collision between rigid theological dogma and freedom of speculation within natural philosophy, the precursor to modern science" (Shackelford, 2009, p. 60). Its importance is so critical that Bruno's death is used by historians to mark the transition from the "Renaissance philosophy" era to the "Scientific Revolution" era (Ingegno, 1998). A scientific think tank in Germany committed to debunking religion is named after Bruno (Higgins, 2007, p. A11). Another recent reference penned to support the claim that Christianity has long repressed science and free inquiry concluded that the best examples of this repression were "the religious censorship of Bacon in the 1200s, the burning of the heliocentrist astronomer Bruno and the censure of Galileo in the 1600s" (Aliff, 2005, p. 150). In fact, as I will document, *none* of these examples supports Aliff's claim of church suppression of science (see Bergman, 1981).

Repeating the same erroneous claims about Galileo, Kevin Phillips wrote that the "papacy found Galileo guilty of heresy—and placed him under house arrest for seven years until he recanted—for propounding the Copernican argument that the earth revolved around the sun," and then added that "in 1600 philosopher Giordano Bruno had been burned in Rome for much the same offense" (Phillips, 2006, p. 227). Harvard Professor David Landes wrote that Galileo was not the first, nor will he be the last, to suffer at the hands of the church over science progress:

> Equally momentous, if less remembered, was the burning in Rome in February 1600 of Giordano Bruno ... whose imaginary concept of the universe came far closer to what we now think than that of Copernicus or Galileo: infinite space, billions of burning stars, rotating earth revolving around the sun, matter composed of atoms, and so on. All heresies, linked to mysteries and magic. In effect, by burning Bruno, the Church proclaimed its intention of taking science and imagination in hand and leashing them to Rome. (Landes, 1999, p. 181)

For an excellent review of why these claims about Copernicus and Galileo are erroneous, see Moy (2001).

Bruno not a Scientist

Although, historically, the lines between what we call science and religion were not clearly drawn, it is clear that few professional science historians, if any, consider Bruno a scientist. Both his masters and doctorate were in theology. The major histories of science, including Dampier (1949, p. 112), Lindberg (1992), North (1995), Heilbron (2003), Grant (2004), and Singham (2007, p. 28), never mentioned Bruno even once. Some historians of science, such as Goldstein (1988, pp. 85–86), mention him as a philosopher.

As far as is known, he never collected data, never did scientific experiments, or made testable scientific observations, as did Galileo; rather, his many books were based solely on philosophical speculation. Although Bruno was neither a scientist nor an astronomer but a theologian and philosopher, he did cover cosmology as part of his lectures. Furthermore, Bruno saw himself as a philosopher of religion, not a scientist (Boulting, 1972, p. 272). His long career as a college professor and as a tutor at several leading universities is extensively documented in a sympathetic biography titled *Giordano Bruno: Philosopher, Heretic* (Rowland, 2008).

Bruno's occult involvement especially caused him difficulties with both the church and state. For this reason, "many historians of science have rightly denied to Bruno a place in the history of science" (Peters, 1989, p. 243). Thus, Bruno biographer Dorothea Singer concluded from her extensive study of his life that Bruno was "in no sense a man of science" (Singer, 1950, p. v).

It is commonly implied, or openly stated, that the reason Bruno was executed on February 16, 1600, by the Italian government was because he challenged church dogma, such as claiming that the earth moved around the sun (heliocentrism), and not the sun around the earth (geocentrism). The long paper trail in his case, though, clearly shows that it was not his Copernicanism that got him into trouble, but his theological beliefs, such as his teaching that there is "no personal God" but rather "we are in God, and God is in us" (White, 2002, pp. 7, 48).

In the words of Rowland, Bruno reasoned that "God would be nothing without the world, and, for this reason, God did nothing but create new worlds" (Rowland, 2004, p. 197)—this was the essence of Bruno's infinite worlds theology. Bruno did support Copernicanism but only to advocate "Hermetic religion as a corrective for the woes of Reformation and Counter Reformation Europe" (Shackelford, 2009, p. 61). This position put him not only in the religious sphere but in the political arena as well, which was central to his later problems.

His rejection of the orthodox Christian view of the Trinity, which he held as a young man, and his conclusion that Jesus "could not have been the son of God" were probably even more important reasons for his troubles and branding as a heretic (Rowland, 2008, p. 57). Nonetheless, Bruno made an extraordinarily difficult defendant because "his uncanny ability to put orthodoxy itself into a historical context made the certainties of dogma look uncertain" (Rowland, 2008, p. 58).

Dorothea Singer (1950, p. 5) concludes that Bruno's whole philosophy was based on his belief in an infinite universe and infinite inhabited worlds—both ideas widely rejected then and still today, even by most big-bang cosmologists. Bruno believed not only in an "infinite universe," but also one that "carried the seeds of its own propagation everywhere" (Rowland, 2004, p. 197). Most scientists in Bruno's day were not supportive of Bruno's ideas. Many prominent scientists, including Galileo and Johann Kepler, were not sympathetic to Bruno, partly because he espoused a Copernican system for mystical rather than for scientific reasons (Lerner and Gosselin, 1973).

Bruno's Early Life

A precocious boy, Bruno became a Dominican at age 14 and wrote a total of over 60 works, mostly on theology, metaphysics, philosophy, the art of memory, and esoteric mysticism (Brinton, 1890, p. 12). His writings made him a "maverick, a misanthrope, and an extreme intellectual radical," who "actually courted danger and controversy" by openly "confronting his enemies head-on" (White, 2002, p. 48, 9). Rowland wrote that "Bruno's keen wits were never tempered by charity toward his weaker colleagues," and he often referred to his peers in very disparaging terms (Rowland, 2008, pp. 113–114).

He was "at first welcomed" during his 16 years of wandering over Europe from university to university as a professor, tutor, or author. But it was never for long because he was so radical and uncharitable. Although as a lecturer he held his listeners spellbound, it was not long before "his presence always led to embarrassment" (Rowland, 2008, p. 132; see also, Singer, 1950, p. v).

This view is well recognized by Bruno scholars. Lerner and Gosselin conclude that "the common claim that Bruno challenged an ignorant and obscurantist Catholic church in a modern spirit of freedom" is largely a myth (Lerner and Gosselin, 1986, p. 126). The claim that Bruno was a "failed Galileo" was "congenial to the worldview of the 19th-century liberal" who opposed Christianity (Learner and Gosselin, 1986, p. 126), and it has been enshrined in twenty-first-century mythology. Bruno "regarded himself as ... [the] prophet of a new religion," and interest in his works was especially strong among those trying to fill the "spiritual void" left by their disillusionment with organized religion (Berggren, 2002, p. 30).

Bruno's Problems in Society

A prolific and popular author (some of his works are still in print today—see Blackwell, 1998), Bruno was also a rebel who, when still a young man, was accused of Arianism, iconoclasm, and the possession of heretical books. After he left the Catholics, Bruno joined the Calvinists at Geneva (De Leon-Jones, 1997). He soon encountered problems with them—evidently mostly because of doctrinal disputes and his strongly worded attacks against Aristotle (White, 2002, p. 105). The church, both Catholic and Calvinist, was so wedded to Aristotle that professors in their lectures rarely deviated "even the slightest bit from the opinions of Aristotle" (Rowland, 2008, p. 100). Brinton reports that when in Geneva, Bruno was "thrown into prison for defamatory libel" (Brinton, 1890, p. 12).

According to Ernan McMullin, the Oxford professors were also outraged because they believed one of Bruno's lectures was plagiarized from Marsilio Ficino (1433–1499). The "opprobrium of the university dons and many of the students" was so strong in England that Bruno "was all but physically expelled from the city" (White, 2002, p. 110).

Bruno next went to France, where he became a professor at the Sorbonne. Soon problems developed there, and after only two years, he was forced to move to England. After three years, he was also forced to leave England because (among other allegations) he repeatedly insulted the professors at Oxford University, claiming that they "knew much more about beer than about Greek" (Singer, 1950, p. 33; Boulting, 1972, p. 85).

Bruno soon migrated to Germany and was again excommunicated in 1590, this time by the Lutherans. Much, if not most, of Bruno's problems were with university faculty, one example being the rector of the University of Marburg. The rector wrote that Bruno

> "went so far as to insult me in my home as if I had acted against the public interest, the custom of all the universities of Germany, and the good of knowledge." The rector erased Bruno's name from the university register, noting in the margin that the erasure had been done "with the unanimous consensus of the faculty in philosophy." One of those faculty members, in turn, erased the rector's note; apparently the faculty was not so unanimous after all, nor the rector so universally popular. (Rowland, 2008, p. 198)

In Marburg "he was obliged to flee in order to escape the 'malevolence' of the rector of the University" (Brinton, 1890, p. 14). Brinton opined that Bruno fled from the Lutherans of Marburg and Helmstedt to save his life. Bruno next went to Tübingen University, where he was paid to move elsewhere (Rowland, 2008, p. 209). He was forced to hastily depart from a total of ten cities in ten years, not due to his views on science, but because he managed to alienate not just the Catholic university faculty in both France and Italy, but also their Lutheran and Calvinist counterparts in other countries. His "combative personality, both in public and in print" often was at the center of many of his conflicts (Rowland, 2008, p. 202).

Returning to Rome, he was excommunicated yet again by the Catholic Church, not for teaching the theory of Copernicus, but for heresy and blasphemy by denying the divinity of Christ and asserting that Christ did not perform miracles but was actually a magician who only appeared to work miracles. His teaching that most, if not all, heavenly bodies were populated by life and that all stars and planets were themselves living also caused him major problems (Rowland, 2008, p. 174). He could not have been in trouble for espousing a moving earth and an infinite universe because "Copernicanism was not declared a heresy until 1616 [Bruno died in 1600] and, as for the infinite universe view, he was simply echoing Cardinal Nicholas of Cusa" (Hannam, 2009, p. 309).

Contemporary reports added that Bruno was "quick in temper, bitter in debate, violent in language, impatient with ignorance, full of scorn for prejudices; not a pleasant, easy-going fellow by any means; given at times to vainglorious boasting" and his prose was "so coarse that it sometimes passed beyond buffoonery into what to us seems indecency" (Brinton, 1890, pp. 17–18). The record is clear: his "views brought him into conflict with the Orthodox academics" in the university of his day (Shackelford, 2009, p. 61).

His ideas were not based on scientific observations but on his philosophical worldview. Rather than being a brilliant scientist martyred for truth, Bruno has been described by some as a misguided quack. Lerner and Gosselin describe his most important work, *The Ash Wednesday Supper*, as follows:

> It appears to be a compendium of nonsense—a disorganized display of gross error connected by incomprehensible passages. Bruno has the Copernican model of the solar system wrong. He demonstrates total ignorance of the most elementary ideas of geometry, let alone geometric optics. He throws in scraps of pseudoscientific argument, mostly garbled, and proceeds to high-flying speculations that seem disconnected from the preceding or subsequent arguments. Even the diagrams do not always correspond to the accompanying discussions in the text. (Lerner and Gosselin, 1986, p. 126)

Under the subheading "Strange Cosmologies," John Grant wrote that Giordano Bruno's "version of Copernicanism" was really "incidental to his own mystical, theistic cosmology." In fact, Bruno evidently

> despised Copernicus as a mere mathematician, and … accepted the planets' revolution about the Sun for reasons more associated with magic than with science. Bruno's cosmology is hard for the modern mind to understand, but appears to have had strong connections to animism. The Universe was of infinite extent, and contained an infinite number of inhabited worlds. There was no deity who could be regarded as an individual; instead, the magic of

> Nature was the deity, present in all things. This deity was reflected in human beings in the form of the creative imagination. (Grant, 2006, pp. 88–89)

It was clear at his trial that his writings were "purely philosophical" (Boulting, 1972, p. 267). One example was his belief in the "infinity of worlds," the existence of an endless number of worlds like our earth (Boulting, 1972, p. 268). Bruno's speculations on an evolutionary theory of the natural world, which he called "progressive development," were no doubt developed by reading the Latin poet Lucretius, whom he often quoted (Boulting, 1972, p. 139). Brinton wrote that Bruno's view of evolution was developed

> to the full extent of the most advanced evolutionist of to-day. "The mind of man," he says, "differs from that of lower animals and of plants, not in quality, but only in quantity." "Each individual," he adds, "is the resultant of innumerable individuals. Each species is the starting point for the next." Change is unceasing. ... He extended these laws to the inorganic as well as the organic world, maintaining that unbroken line of evolution from matter to man which the severest studies of modern science are beginning to recognize. (Brinton, 1890, pp. 21–22)

In short, "the combination of newfangled and absurd theology with an unerring ability to rub people the wrong way meant that he could rarely stay put for long" (Hannam, 2009, p. 307).

Bruno's Nonclerical Enemies

Many of Bruno's problems involved his nonclergy enemies, such as the wealthy Venetian businessman Giovanni Mocenigo. Mocenigo personally strongly disagreed with Bruno's ideas and was so determined to convince the church to convict Bruno of heresy that he used entrapment and then deception to get the church to act against him (Berggren, 2002, p. 31). White wrote that Mocenigo was actually desperate to convince the Inquisition that Bruno was a first-class enemy of the church. In his second statement to the Inquisition, Mocenigo became so involved in his claims that he told

> Bruno he will not report him if the magus will finally submit to teaching him the occult arts. In most ways, though, this second statement is little more than a reiteration of the first [statement], for Mocenigo had clearly run out of ideas or accusations to pin on Bruno. (White, 2002, p. 94)

By this time Bruno had enough enemies, both secular and sacred, that the authorities in Italy were convinced they should imprison him. His "cosmological opinions ... were never questioned," and he was delivered "without the slightest opposition of the civil government ... to the Inquisition of Rome" (Brodrick, 1961, pp. 207, 339). Bruno compounded matters by lying to interrogators—during his trial he "denied any link with the mystical arts, but the evidence for his close association with magic could be found in his books and through his known connections with Hermeticists [the followers of Hermes]" (White, 2002, p. 38). Hermes was believed to be an Egyptian priest who lived not long after Moses, though recent scholarship places him after the beginning of Christianity. His works often focused on the occult, especially astrology and alchemy. Bruno's writings reveal that he rejected many of the scientific advances of the Middle Ages and wanted to return to the ideas of the pre-Mosaic Chaldeans and Egyptians (Heilbron, 2003, p. 718; McMullin, 2005, p. 177; Huxtable, 1997).

Boulting wrote that Bruno's trial was conducted with moderation, and all of the depositions were "carefully and accurately recorded" (Boulting, 1972, p. 281). A major problem was Bruno's attitude. Bruno once said, "Often have I been threatened with the Holy Office and I deemed it a joke" (Boulting, 1972, p. 264). A review of the court transcripts makes it clear the whole issue was theology, especially his rejection of the Trinity (Rowland, 2008, p. 265). Bruno was accused of theological heresy, praising religious heretics, and even fraud (Rowland, 2008, pp. 288–289).

Bruno rejected many of the central Catholic doctrines, such as transubstantiation and the virgin birth. He even called the pope the "Triumphant Beast" (Boulting, 1972, pp. 299–300). His morals were also problematic. He once told a friend that the "ladies pleased him well; but he had not yet reached Solomon's number; the Church sinned in making a wickedness of that which was of great service in Nature, and which, in his view, was highly meritorious," namely sexual promiscuity (quoted in Boulting, 1972, p. 266).

Bellarmine did draw up a set of eight doctrinal propositions, of which Bruno admitted he violated four—including denying that sins of the flesh were mortal sins (Rowland, 2008, p. 257). The Inquisition in Bruno's case was at first very lenient. When the charges were proven, all Bruno had to do was show repentance and renounce his heresy, but he steadily refused (Boulting, 1972, p. 297). Of note is the difficulty of proving the Inquisition's case—at least two witnesses were required and, in this case, both were questionable, requiring more extensive research. Rowland notes the "fact that Bruno's trial dragged on year after year suggests that Santori and his fellow inquisitors could find no plausible way to obtain a conviction" (Rowland, 2008, p. 252). He was also accused of founding and leading a new sect, a concern then because the Catholic Church was fighting the Protestant schism in several nations (Boulting, 1972, p. 298).

When sentence was pronounced, "his life, studies and opinions were recounted, as well as the zeal and brotherly love of the Inquisitors in their efforts to convert him" (Rowland, 2008, p. 299). Bruno was given eight more days of grace to "repent" but again refused, remaining obstinate, "notwithstanding the theologians visit[ed] him daily" to convince him to mend his ways; and "when the crucifix was held out to him, he turned his face aside in disdain" (Boulting, 1972, pp. 301, 304). Nothing in the surviving record indicates heliocentricity or science had any part in the issues of concern—doctrinal matters were the heart of the church's concern (Rowland, 2008, p. 258). Adamson wrote that Bruno

> possessed no remarkable scientific knowledge, for his own writings condemn him of a degraded materialism and show that he was entangled in commonplace errors. He had no splendid adornments of virtue, for as evidence against his moral character there stand those extravagancies of wickedness and corruption into which all men are driven by passions unresisted. He was the hero of no famous exploits and did no signal service to the state; his familiar accomplishments were insincerity, lying and perfect selfishness, intolerance of all who disagreed with him, abject meanness and perverted ingenuity in adulation. (Adamson, 1903, pp. 307, 23)

In one of the most sympathetic biographies of Bruno, Rowland wrote that his "radical defiance, both of Christian doctrine and of the Inquisition's right to enforce it and even 'to acknowledge the inquisitors authority'" is what forced them to "respond by showing him their power" (2008, p. 268, 273).

Bruno was eventually handed over to the secular authorities, and it was the state that burned him at the stake in the style of the times as a traitor, a man judged dangerous to the welfare of the people. Mercati claimed that this decision was not made hastily:

> Pope Clement VIII kept him confined for seven years, always in the hope of winning him back to the Church and to the order he had abandoned. He was well treated by the Inquisition, given a comfortable room, all the writing materials he requested, and a change of towels, bed and personal linen twice a week. He was allowed out of papal funds a pension of four crowns a month, which enabled him to order whatever food he liked. (Angelo Mercati, *Il sommario del Processo di Giordano Bruno*. In, *Studi e Teste*, 101, 1942, pp. 126 ff., quoted in Brodrick, 1961, p. 207)

A further problem is that Bruno recanted his major heresies early in his imprisonment and then later reaffirmed his original views, making him a relapsed heretic with immolation the normal penalty. Furthermore, his *Spaccio de la bestia trionfante* made the pope into the beast of Revelation, an act beyond heresy and into sedition because the pope was also a secular ruler.

A Martyr for Science?

In the end, Bruno's problems were summarized by Berggren as follows: "There is little doubt that he saw himself as prophet of a new religion—or at least of a new kind of religious insight" (Berggren, 2002, p. 30). Eminent science historian Sir William Dampier wrote that Bruno "openly attacked all orthodox beliefs, and was condemned by the Inquisition, not for his science, but for his philosophy and his zeal for religious reform" (Dampier, 1949, p. 113). Professor Yates, in an entire book on the subject, argued that although often portrayed as a martyr for science, Bruno was no such thing. Rather, he was a magus who traveled across Europe preaching a gospel rooted in mystical Egyptian pantheistic texts, especially the so-called tradition of Hermes (Yates, 1991).

Yates concluded that Bruno's teaching was neither orthodox Catholic nor Protestant doctrine but rather Egyptian magical doctrines (Yates, 1991, p. 239). His magical, mystical alchemy probably alienated scientists more than the clergy. Francois Russo concluded that modern science would not "have been possible without the recognition that in nature" exists

> certain constants, that natural phenomena are connected by permanent relationships. It will be remembered that sixteenth-century Humanism showed one trend that was in complete opposition to this, and that at one time it almost carried the day—when men like Cardan and Giordano Bruno lapsed into a naturalistic pantheism, a panpsychism, according to which the universe was a hodgepodge of uncoordinated wonders. (Russo, 1963, p. 305)

One explanation for Bruno's portrayal as a martyr of science lies in postmodern thinking.

> The orthodox story portrays Galileo too much as the rational man of modernity for him to be wholly satisfactory as a postmodern hero. Fortunately there is an alternative at hand: Giordano Bruno, who appeals more to postmodern sensibilities. Bruno combines Copernicanism with the cabala and with a supposedly ancient Egyptian form of magic. Moreover, he was executed by the church in 1600, allegedly for teaching Copernicanism, so he makes a good substitute for Galileo. This story of Bruno, the martyr to science, combines science with mysticism and is becoming increasingly popular. In fact, Bruno is even less the martyr than Galileo was. (Sampson, 2001, p. 155)

Bruno was not alone in holding to some, or even many, of his mystical ideas (Rowland, 2008). The best example is Isaac Newton, who indulged not only in alchemy but also in the mystical arts. Johannes Kepler also based some of his astronomy on mystical ideas, such as his belief that the planets and other bodies emitted musical harmonies. One critical difference is that both Newton and Kepler did not stop at philosophical speculations but did empirical research and collected data to support their theories, whereas Bruno did neither; instead, he "relied on mental geometries that are strange to us" (Rowland, 2008, p. 282).

Furthermore, Bruno carried his mystical arts far beyond many, if not most, other men of science in an age when most scientists were abandoning such ideas. Newton and others were able to work on their alchemical ideas in relative obscurity. Only recently has the extent of Newton's involvement in the mystical arts been documented and become widely known. Kepler's musical harmonies hypothesis served as a means of developing theories that could be empirically tested. Their philosophical speculations clearly influenced their work but did not dominate it. It was their data that made their reputations as scientists. Ironically, in spite of Bruno's conflicts with the universities, the scholars, the state, and the church, he claimed

> everything he had discovered about the immensity of the universe only strengthened his awe at creation and his joy at coming closer to its source. His attention was fixed not on what he had done wrong in his life but on what he had learned in its course, and he was consumed with eagerness to communicate those discoveries. Furthermore, he observed repeatedly that in deepening his knowledge of the universe, he had also deepened his communion with religion's most basic truths. He quoted Psalm 19 in support of his philosophy: "The heavens declare the glory of God, and the firmament sheweth his handiwork." (Rowland, 2008, p. 190)

Why the Bruno Myth Persists

The main reason for the perpetuation of the Bruno myth is because "post-Enlightenment historical essayists sought to exalt Bruno as an exemplary figure in the struggle for free thought against the confining authority of aristocratic government supported by religious authority" (Shackelford, 2009, p. 63). Another reason is because his case served as a means of discrediting the Catholic Church in particular and Christianity in general. An example of this is Professor Ira Cardiff, who, first, incorrectly averred that Copernicus "proved the earth NOT to be the center of the universe" by his "mass of astronomical observations," which were not published until he died, a fact that "certainly saved him from martyrdom." Then Cardiff claimed that no progress in science occurred for about 50 years, until "Bruno constructed a philosophy embodying the ideas of Copernicus." Cardiff mockingly concluded that the "Church showed its appreciation of this great work by burning Bruno at the stake" (Cardiff, 1942, pp. 54–55).

Several recent references have endeavored to correct the myth. For example, Grant wrote that "one of the classic tales within the history of science is that of Giordano Bruno (1548–1600), burnt at the stake for his support of the new Copernican cosmology ... the story of Bruno as a martyr in the name of science—with the implicit corollary that the Church condemned scientific progress—is false" (2007, p. 151). Grant adds that in "more modern times Bruno would have been regarded as a (probably) harmless lunatic." Unfortunately, the myth was made secure by many widely read and respected scientists and authors from John Tyndall to Henry Fairfield Osborn (Shackelford, 2009, pp. 63–64).

One positive result of the Bruno affair is that it "influenced the Church away from a policy of punishment toward a policy of persuasion" (Rowland, 2008, p. 283), partly because, in spite of his numerous violations of both church doctrine and moral law, many high-level church leaders saw what happened to Bruno as a major injustice. If Bruno had acknowledged the authority of the church and state, he likely would not have been executed.

Conclusion

The evidence demonstrates that the common belief that Bruno was the "first martyr of science" is historically inaccurate (Pearcey and Thaxton, 1994). One reason for this misperception was the "fact that Bruno had been an advocate and popularizer of heliocentricism [which] may have led to the later perception that he was the first martyr of the new science" (Singham, 2007, p. 28).

University of Wisconsin science historian Ron Numbers in a PBS interview on his research about Galileo stated that not only is there "no reason to believe that Galileo at any point faced the threat of death," but also there "was never any indication in the court records of death being a possible penalty, and no other scientists were put to death for their scientific views" (PBS, 2006). In answer to the question, "Is it the case then that there have been no scientists killed for their scientific views?" Numbers replied, "I can think of no scientist who ever lost his life for his scientific views" (PBS, 2006). None. Thomas Kuhn stated flatly, "Bruno was not executed for Copernicanism" (Kuhn, 1985, p. 199). Angelo Mercati wrote that Bruno, a former

> Dominican friar, had long ceased to believe in Christianity before he was imprisoned by the Roman Inquisition. His cosmological opinions, borrowed anyhow from Cardinal Nicholas of Cusa, were never questioned. To make him a martyr of science, as some have done, is merely silly, as he never engaged in any kind of scientific activity. (quoted in Brodrick, 1961, p. 207)

Olson states bluntly that it was "because of his advocacy of Hermetic magic and his claim that Moses and Christ were magi and not for any astronomical views that Giordano Bruno was condemned by the Holy Office of the Inquisition" (Olson, 2004, p. 58). Edward Peters added that the Galileo and Bruno cases became so widely publicized that they

> shaped much of the early social and cultural self-perception of modern scientists. The execution in Rome of Giordano Bruno in 1600 and the penance imposed on Galileo Galilei, also in Rome, in 1633 constituted the core of … the myth of the martyrology of science and the role of the Church, specifically *The Inquisition*, in creating martyrs of science and opposing the progress of scientific discovery. … The names of Bruno and Galileo were frequently linked and the cause for which they both suffered was identified as the cause of reason and science, opposed to superstition and obscurantism, represented by theologians and directed by *The Inquisition*. (Peters, 1989, p. 243)

This essay shows that the claim (copied below) made by Dr. Tiemen De Vries', a popular Freethinker author of the early 1900s, is worse than irresponsible:

> And almost the last martyrs [of science] were Galilei, Copernicus and Giordano Bruno, the last of whom was burned at the stake in Rome in the year 1600, because of his scientific researches [that were] in conflict with the guesses of the church which were articles of faith. The murder of Giordano Bruno is one of the most atrocious and most blasphemous crimes of the Papacy and we may add of the whole world's history. Bruno was teaching in accordance with Copernicus that the earth did not stand still but moves on its axis and around the sun, which as the whole world knows now, was right. The Pope was commanding the faithful to believe that the earth stands still, which was not true. (De Vries, 1932, p. 141)

De Vries then condemns the pope for putting the Bible above science.

From a modern vantage point, what Bruno did does not in any way justify either the actions of the state or the Inquisition. Much of Bruno's fame and influence *resulted* from the way he met his end, which created both sympathy and much curiosity about him (Singer, 1950). Bruno read widely and synthesized what he read to produce many ideas, some of which can be interpreted as providing insight on scientific ideas accepted today, but much that he wrote was clearly foolish.

If he had died a natural death, his ideas and writings may well have been buried in history, of interest to no one. His inglorious death made him a martyr, even a hero, to many. The event was seized on by the anticlerical movement and anti-Christian rationalistic skeptics to discredit the Catholic Church (Sánchez, 1972).

Many myths still exist about Bruno, including claims about his support for righteous causes. The myth briefly examined in this paper, that Giordano Bruno was the first martyr for science, is not supported by history. The common claim, such as by Stephen Jay Gould that sciences' "true martyrs—Bruno at the stake, Galileo before the Inquisition—or, in better times, merely irritated, as Huxley was, by ecclesiastical stupidity" is historically false (Gould, 1991, p. 400). The fact is, in the words of Cambridge-trained historian of science James Hannam, "Contrary to popular belief, the Church never … burnt anyone at the stake for science ideas" (Hannam, 2009, p. 3).

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Beyond "Origin & Operation" Science,

Part I: Critique of OS²

John K. Reed and Peter Klevberg*

Abstract

The terms "origin science" and "operation science" are used to explain the nature of science, especially as it relates to history. But they are an inadequate response to positivism. The proposal for multiple kinds of science was an attempt to answer claims from the 1980s creation trials that evolution was science and creation was religion. Proponents of "origin" and "operation" science sought an alternative *inside* science, rather than in the broader context of the Christian worldview. In addition to problems in their view of the history of science, "origin science" fails its own criteria and "operation science" is redundant. The past and singularities, key factors in this scheme, are not proper topics of science. Finally, the proposal includes a deficient understanding of uniformity and mistakenly accepts the "god-of-the-gaps" fallacy and methodological naturalism.

Introduction

Most Americans hear the word "vehicle" and picture a car zooming down a road. But the term might encompass anything from a snowmobile to an airboat. Context is critical. The same is true when we navigate the nature of science. Enlightenment secularists insisted that science created its own context. This "positivism" was anchored in Hume's (1748) conclusion that true knowledge consists only of "any abstract reasoning concerning quantity or number" or "any experimental reasoning concerning matters of fact and existence." There is no doubt that he wished to diminish the roles of revelation, theology, and philosophy. This agenda proceeded, and by the end of the nineteenth century, this idea had led to the rise and fall of *logical positivism*, leaving a residual belief in the infallibility of science in a truncated, materialist worldview. Positivism has proven a potent argument against Christianity's revelatory truth. Modern secular man sees "science" as hard fact and biblical truth as "blind faith." This confidence in science was extended to natural history by Lyell's uniformity principle and Darwinian evolution.

Although the secular worldview is self-refuting, positivism remains embedded in culture—more as a subjective axiom than a rational position, but its residual power drove the legal decisions against teaching creation and intelligent design in the state schools. Creationists have begun to respond to these claims by proposing that science includes different facets, often called "operation science" and "origin science" (OS²).

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These multiple kinds of "science" have gained popularity among creationists in recent years. OS² is a staple explanation of the nature of science in creationist magazines, books, and websites and is invariably presented at an elementary level (e.g., Ham, 2008). An in-depth analysis of this scheme is overdue. While OS² discusses a context of the history and philosophy of science, Geisler and Anderson (1987)—the sole in-depth reference—failed to challenge the root problem of positivism because they kept their solution *inside* science.

Although we agree with many of the ideas of creationists who inconsistently use its terminology, we disagree with this scheme. That is because concessions to positivism cannot be the Christian answer. This is no small semantic issue. As Aristotle noted, "The least initial deviation from the truth is multiplied later a thousandfold" (*On the Heavens*, 271b9–10). Secularists have won too many battles by distorting language—think of words like *science*, *naturalism*, *uniformity*, and *evolution*. Not only does OS² *not* get to the root of positivism, but it is also an unnecessarily complicated solution. It falls into the category that Adler described:

> The positivism or scientism that has its roots in Hume's philosophical mistakes, and the idealism and critical constraints that have their roots in Kant's philosophical mistakes, generate many embarrassing consequences that have plagued modern thought since their day. *In almost every case, the trouble has consisted in the fact that later thinkers tried to avoid the consequences without correcting the errors or mistakes that generated them*. (Adler, 1985, p. 100, emphasis ours)

We will trace the origin and development of OS², critique its main propositions, and, in Part II, propose alternatives that are consistent with biblical truth and the long tradition of Western thought.

Origin and Development OS²

OS² appeared after court cases in Arkansas (MacLean vs. Arkansas, 1982) and Louisiana (Edwards vs. Aguillard, 1987) and focused attention on the secular "religion vs. science" argument. Despite disagreement over demarcation criteria by secular philosophers of science (e.g., Laudan, 1983), the positivist argument convinced both of these courts. Clearly, Christians had to address this secular distortion. This was done by Geisler, who first used the term "science of origins" to describe investigations into the unobserved past. This is the original appearance of the concept in print:

> The two fundamental principles of science, observation and repetition, are absolutely crucial when we are dealing with phenomena of the present world. However, when we are dealing with origins *neither observation nor repetition applies*. … This means that in the strict sense of the word *science* … there can be no science of origins. (Geisler, 1983, pp. 134–135, emphasis his)

We agree with that final statement. But Geisler discovered such a science in spite of himself. He proposed a "science of origins" that relied on four principles:

> But the lack of direct access to the events of origin does not mean that there can be no scientific approach to them. For there are several other principles of science which apply to past events we cannot observe. First, the principle of *causality* is operative for past events. … Second, there is the principle of *uniformity* (or analogy). … Third, there is the principle of *consistency*. … Fourth, there is the principle of *comprehensiveness*. (Geisler, 1983, p. 135, emphasis in original)

This brief introduction was expanded by Thaxton et al., who coined the terms "operation science" and "origin science" and introduced the basic dichotomy:

> Such theories are operation theories. That is, they refer to the ongoing operation of the universe. We shall call the domain of operation theories *operation science* for these theories are concerned with the recurring phenomena of nature. … Unlike the recurring operation of the universe, origins cannot be repeated for experimental test. The beginning of life, for example, just won't repeat itself so we can test our theories. In the customary language of science, theories of origins (*origin science*) cannot be falsified by empirical test if they are false, as can theories of operations science. (Thaxton et al., 1984, pp. 202, 204, emphasis in original)

Probe Ministries was a point of connection for these authors. It is no surprise, then, that the most detailed treatment of OS² was written soon afterward by Geisler and J. Kerby Anderson (1987). That book remains the only in-depth discussion (contra Chaffey and Lisle, 2008; Cosner, 2013; DeWitt, 2007; Ham, 2008). In contrast to the emphasis of scientific creationists on scientific content, Geisler and Anderson (1987) emphasized the history and philosophy of science, though it is incorrect to think those subjects were ignored by scientific creationists (e.g., Klotz, 1966; Morris, 1965).

Geisler and Anderson (1987) correctly saw the Enlightenment distortion of science, but they apparently did not see the depth to which positivism had penetrated Western thought. As a result, their attempt to rescue science fell short. However, their scheme is self-consistent. It is built around an attempt to scientifically investigate what they called *primary cause* as well as *secondary cause*. They got around the common understanding of science by subdividing it based on the two dichotomies of *past/present* and *regularity/singularity* (Figure 1). Using those as endpoints in a four-cornered graph, they distinguished four types of science; each focused on its own particular area (Figure 1B).

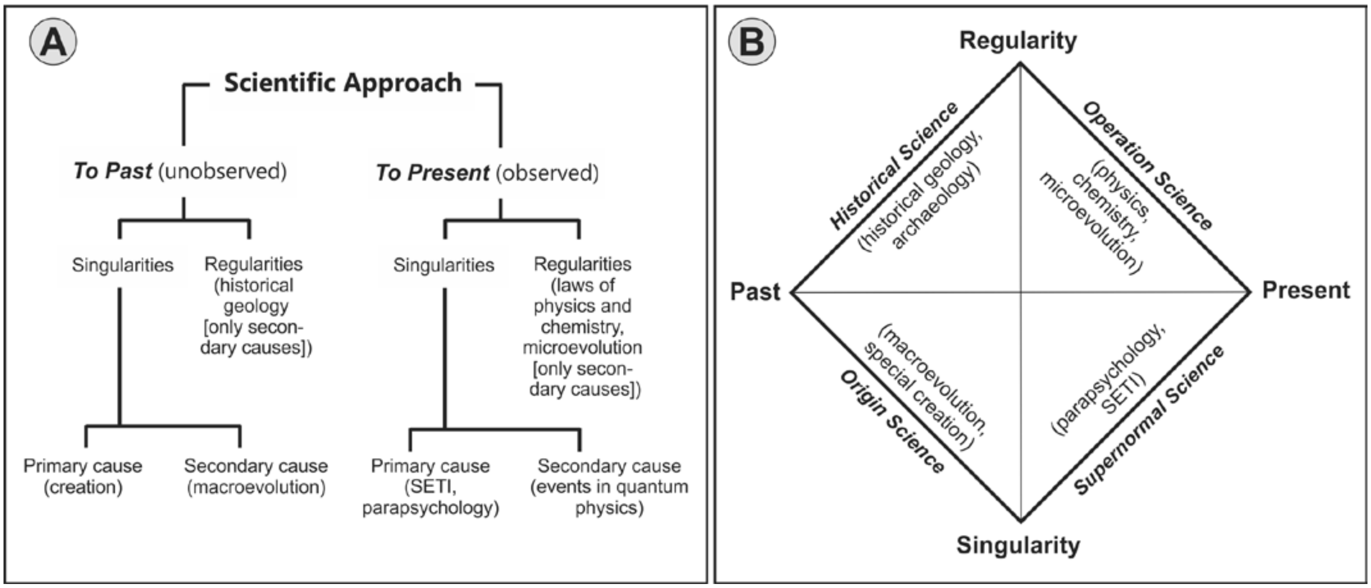

Figure 1. Geisler and Anderson (1987) derived four kinds of science based on their classification criteria of past vs. present and regularity vs. singularity. From Geisler and Anderson (1987, their figures 1 and 2).

More than a decade later, creationists began using OS² to explain science and to justify their opposition to geohistory and biohistory, so as to avoid the charge of being "antiscience" while still casting doubt on evolution and uniformitarianism. The simplicity of OS² allowed it to be used in lay publications to answer anticreationist propaganda. A search for "origin science" on the websites of the large creationist ministries returns results of this type. Typical is the article, "Do creationists reject science?" (Galling, 2008). Similar treatments could be cited. The point is that creationists have picked up the torch for OS².

Playing Field Is History and Philosophy of Science

Geisler (1983), Thaxton et al. (1984), and Geisler and Anderson (1987) realized that the two key areas in this debate were (1) the philosophy of science and (2) the history of science. In dealing with the philosophy of science, they made two errors. First, they assumed science provided neutral common ground with secularism. That misimpression has been used since the Enlightenment to discourage Christians from confronting naturalism *as a worldview*. Second, despite acknowledging the role of the philosophy in defining science, they sought a solution within science. OS² thus ignored the root of the problem—positivism. That key component of naturalism (Figure 2) links materialism and uniformitarianism. If ultimate reality is matter/energy (materialism), then truth must come from their study via science (positivism). Science is extrapolated into the past by uniformitarianism (Reed, 2001, 2013). Seen by this light, science becomes secular holy writ:

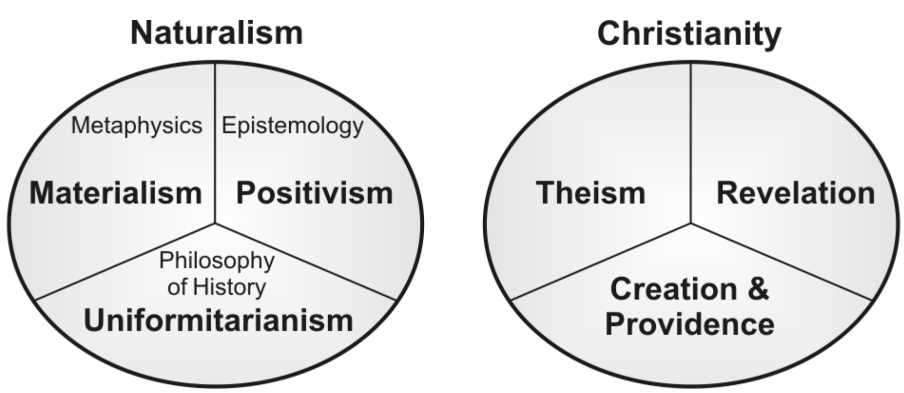

Figure 2. Positivism is the logical epistemology of naturalism, flowing from its view that matter and energy are ultimate reality. Positivism replaced the epistemology of revelation that dominated the Christian West for centuries. From Reed (2001).

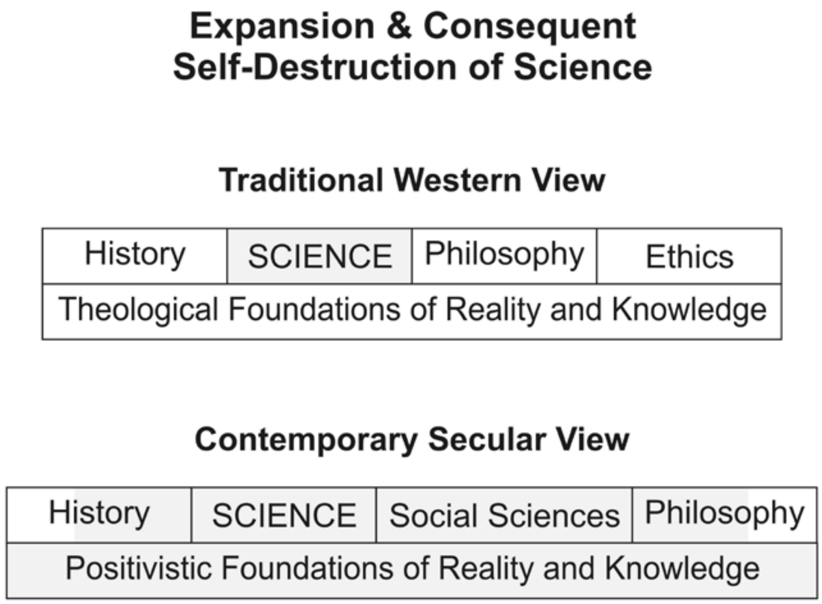

Figure 3. Traditionally, science was one of several empirical human disciplines (top). Positivism has pushed it into areas unsuited for its method (bottom), forcing vagueness in its definition. Because science displaced revelation as truth's benchmark (Figure 2), truth too is being lost.

> I know that there are enough varieties of positivism to permit the professors to retain their individuality, but I insist that behind the multiplicity of technical jargons there is a single doctrine. The essential point … is simply the affirmation of science, and the *denial of philosophy and religion*. (Adler, 1992, pp. 31–32, emphasis ours)

One consequence of positivism has been an attempt to make sure and certain knowledge "scientific" (Figure 3). But when science claims to explain *everything*, it actually explains nothing. Absent transcendent truth and absolute ethics, optimistic scientism cannot justify its presuppositions and so eventually falls prey to pessimistic nihilism. As a result, they are two sides of the same coin (Rose, 2009). The slide from optimism to pessimism corresponded to the growing loss of confidence in science, reflected in the popularity of psychological and sociological explanations of science derived from Kuhn (1962) at the expense of more traditional descriptions (e.g., Popper, 1965). Recent philosophers have noted the failure of the old demarcation criteria and have become more skeptical, even to the point of arguing against the existence of a "scientific method" (Bauer, 1992; Cleland, 2011; Feyerabend, 2010; Laudan, 1983, 1996; Moreland, 1989). Lacking absolute truth, scientific ethics are adversely affected, and then credibility (*Economist*, 2013).

OS² also highlighted the history of science, a pursuit continued by Thaxton, who coauthored *The Soul of Science* (1994) with Nancy Pearcey and Marvin Olasky. But the works in the 1980s missed the extent of the secular deception. To be fair, Enlightenment mythmaking was still powerful; secularists have long striven for a "scientific" history to refute the Bible:

> This attempt *to make history scientific* originated in the positivism of Auguste Comte. The term positivism was used to contrast the reliable methods of natural science with the ethereal speculations of metaphysics; and while later positivistic historians may not accept other parts of Comte's philosophy, the term itself is not too inaccurate. The aim is to discover laws by empirical observation. (Clark, 1994, pp. 99–100, emphasis added)

Geisler and Anderson (1987) tentatively discussed Christian roots of science but lacked the perspective of more recent authors like Stark (2003, 2005) or Mangalwadi (2012), especially in noting the key insight that because science was a Christian enterprise, its use as a weapon against faith is self-refuting (Reed et al., 2004).

OS² also failed to address the essential role of prehistory in the secular worldview (cf. Mortensen, 2004a, 2004b). Prehistory muddles the very definition of history by transferring the bulk of Earth's past to the domain of science. History was once the study of past events, defined by its own peculiar questions, method, and specific objects of inquiry. It evolved into a discipline defined by a point on a timeline (Reed, 1999). On one side was "history" (e.g., Collingwood, 1956), and on the other was "scientific prehistory." The criteria for establishing that point are nebulous, and the new "history" diminishes God and man. God is relegated to far away and long ago, and man is a random evolutionary development. Determinism and nihilism are the end result. Intellectuals thought they could have the benefits of God's creation without God, despite the non-Western world showing that to be unlikely at best (Mangalwadi, 2012; Stark, 2003, 2005). Science is a child of Western Christianity; regions dominated by other worldviews, such as Hinduism, have not done the same.

Critique of OS²

OS² falls short of recapturing a Christian view of science (Table I). Since secularists see science as *truth*, they remain blind to the deeper truth behind it and so miss a number of logical fallacies (Lisle, 2009; Reed, 2001; Rose, 2009). Christianity gave birth to science by providing an external framework of infallible truth in God that justifies fallible truth in science (Reed 2001). So how well does OS² recapture that foundation to combat positivism? Compared to other attempts, Geisler and Anderson's (1987) effort was anemic (Glover, 1984; Gould, 1987; Hooykaas, 1972, 1999; Rudwick, 2005, 2008; Stark, 2003, 2005). They did not question basic secular myths like Galileo's "persecution" by the "antiscience" church or the "god-of-the-gaps" canard. Not only did they accept the secular falsehood of a seventeenth-century scientific revolution, but they also multiplied that mistake by failing to see how the theological orientation of seventeenth-century culture created a ubiquitous sense of God's immanence (Hooykaas, 1999; Wells, 1994) that would not have allowed a positivistic epistemology.

But the primary arena is in the philosophy of science. What criteria define science and insure its relationship to truth? Geisler and Anderson's (1987) criteria fail historically (as science was originally conceived) and fail logically to show a clear distinction between Christianity and naturalism. Their fundamental assertion that science can address *primary cause* is contrary to the traditional Christian view, and the dual dichotomies that define their four kinds of science allow too much positivism. Furthermore, key terms and concepts are not correctly defined. Given these problems, creationists should be wary of OS².

One possible reason for these shortcomings is seen in the timing; OS² appeared during the transition from optimistic scientism to pessimistic postmodernism. It rightly perceived the problem but took the wrong path to solve it, assuming science could validate its own truth. Thus, we should expect differences between OS² and secular positivism:

> Our proposal then, is that there are two basic kinds of scientific explanations: primary causes and secondary causes. Likewise, there are two basic kinds of events: regularities and singularities, either of which may occur in the past or the present. It is clear that natural (secondary) causes are the only legitimate kinds of causes to posit for a regular recurring pattern of events. However, singularities, whether past or present … can have a primary or supernatural cause. But whether they have a supernatural or a natural cause, past singularities come within the province of origin science. (Geisler and Anderson, 1987, p. 17)

We should also expect these differences to fail to effectively refute the secular epistemic stance.

Aside: How Many Kinds of Science?

Many creationists use OS² inconsistently. They refer to *two* kinds of science: origin(s) science and operation(s)(al) science (e.g., Chaffey and Lisle, 2008; Cosner, 2013; Patterson, 2007). Yet Geisler and Anderson (1987) proposed four: *origin*, *operation*, *historical*, and *supernormal* (Figure 1). All are integral to OS². If the premises of OS² are accepted, all four logically follow from the dual dichotomies of *past* vs. *present* and *regularity* vs. *singularity* (Figure 1A). *Operation* science addresses present regularities. *Historical* science addresses past regularities. *Origin* science addresses past singularities, while *supernormal* science addresses present singularities. Creationist discussions typically ignore historical and supernormal science or conflate *origin* and *historical* science. In fairness to Geisler and Anderson (1987), the scheme should be used as it was proposed.

Table I. Problems with OS². These can be divided into historical problems and philosophical problems.

Problems with OS²

History of Science	Insufficient critique of secular myths
	- 17th-century origin-of-science "revolution"
	- misses 17th-century theological culture
Philosophy of Science	4 criteria of "origin science" inadequate
	"Primary cause" is not proper topic for science
	"Singularities" cannot be investigated by science
	OS² criteria of science are shallow
	"uniformity/uniformitarianism" incorrectly used
	"methodological naturalism" accepted
	"god-of-the-gaps" fallacy accepted
	no distinction between "science" and "history"
	truth in science needs foundation of absolute

Since "origin science" cannot address regularities based on controlled observation, it must rest on Geisler's (1983) subsidiary criteria of (a) causality, (b) uniformity, (c) consistency, and (d) comprehensiveness. We will first show that these four criteria are insufficient, compare OS² criteria for science in general to other proposals, address primary and secondary cause, examine uniformity, deal with the dual dichotomies, and critique secular myths of methodological naturalism and the "god-of-the-gaps" fallacy.

Failure of Criteria of Origin Science

None of Geisler's (1983) subsidiary criteria can bear the weight of "origin science." First, *causality* is a fundamental presupposition of *all* human knowledge, not just "origin science," as recognized long ago by Aristotle:

> Knowledge is the object of our inquiry, and men do not think they know a thing till they have grasped the 'why' of (which is to grasp its primary cause). (*Physics* II-3, 194b 16–21)

Philosophy and theology lean heavily on causality, as does the Bible. In Genesis 1, *God spoke* (cause), *and it was* (effects). Causality cannot discriminate between disciplines because knowledge that rejects causality has no truth value and is no knowledge at all. Second, *uniformity* (addressed more fully below) was neither defined nor applied correctly by Geisler (1983) or by Geisler and Anderson (1987). Being an assumption of all empirical observation, of which science is but one branch, uniformity cannot discriminate a distinct "origin science," especially vis a vis "operation science." The third criterion of *consistency* has the same problem. Restated as the law of noncontradiction, it is axiomatic of all truth. Fourth, *comprehensiveness*—defined by Geisler (1983, p. 135) as, "A good model explains all available data"—applies to any theorizing in any discipline. Thus, Geisler's (1983) original four criteria are not sufficiently specific to carve out a distinct "origin science."

Criteria of Science Compared

One of the projects of philosophers, historians, and scientists in the last two centuries has been the establishment of criteria to define science (Adler, 1965; Kuhn, 1962; Laudan, 1983, 1996; Meyer, 2000; Popper, 1965). Often, this project is motivated by animosity to Christianity; criteria are sought that enhance the positive reputation of science and dismiss or demean "religion." Interest in these "demarcation criteria" intensified during the creation trials of the 1980s and the Kitzmiller vs. Dover trial (2005). Despite court victories, secularism has been weakened in the eyes of many Christians (Plantinga, 1997) and atheists (Laudan, 1983) to the point where "most contemporary philosophers of science regard the question, 'What methods distinguish science from nonscience?' as both intractable and uninteresting" (Meyer, 2000, p. 6).

A complete solution of the demarcation problem is beyond this paper. However, the problem is relevant because the legal context seems to have exerted a disproportionate influence on Geisler, Thaxton, and Anderson. If science cannot be objectively defined, its rich influence on Western thought is merely psychological or sociological, and the loss of confidence in an ability to define science parallels a loss of the Christian worldview. The question "What is science?" *is* confusing when the prior question "What is truth?" is ignored. Increasing pessimism in science (e.g., Feyerabend, 2010) ironically has grown out of the simplistic "science vs. religion" assertions captured in the 1980s court cases. Secularists were forced to confront the reality that their old reliable definition of science did not cover evolution or the big bang. Philosophers—absent Christian presuppositions—know that truth is not a given. In fact, many have petulantly abandoned truth (the essence of "nihilism" per Rose, 2009) because science cannot justify itself.

The first important distinction between naturalism and Christianity is that in the latter, method is subsidiary to truth. As Rose (2009, p. 11) noted, "Error can be conquered only by Truth." All criteria of method (including those of OS^2, Figure 1) make sense only in that context. Note the first temptation: "Yea, hath God said…?" (Genesis 3:1 KJV) was a question of truth. Only God speaking to man can guarantee absolute truth, and only that can uphold the limited and tentative truth from science (or any other branch of knowledge).

OS^2 did not develop that foundation but moved straight to method—the dual dichotomies of Figure 1 and Geisler's (1983) criteria for origin science. This was a mistake. Even the method was not done well. For that reason, it is worth comparing OS^2 criteria to those of other philosophers, historians, and sociologists (Figure 4). This comparison does not answer the demarcation problem but assesses the relative depth of OS^2, especially given the failure of Geisler's (1983) four "origin science" criteria.

The criteria of Geisler (1983) and of Ruse (1982) are general and anemic. Adler's (1965) and Stark's (2003, 2005) are more specific and reflective. They cast doubt on pure scientific knowledge of the past. This problem can be traced to Lyell; he misused uniformity (Gould, 1987) to take advantage of the public's view of Newtonian mechanics, trying to create similar faith in his historical speculations (Reed, 2010). Adler (1965, p. 106) was more correct than Anderson and Geisler (1987) when he asked:

> How is history to be differentiated from science as a distinct branch of learning or mode of inquiry? Everyone knows the answer. Science and history have different objects of inquiry—not just materially different objects, but objects different in type. Hence, the questions they ask and the methods they employ to find the answers are also different in type. Scientific inquiry asks the kind of questions which call for *general* statements or formulae as answers; these are statements about classes of objects, not about particular instances. Historical research, on the other hand, asks the kind of questions which call for statements about *particulars*; these are statements about singular happenings or existences which have unique temporal and spatial determinations.

Comparing Criteria of Science

Adler (1965)	Ruse (1982)	Geisler (1983)	Glover (1984)	Stark (2003,2005)
(1) Empirical (synthetic) (2) Autonomous (3) Distinct methods/questions and objects of inquiry (4) Knowledge comes from *special experience*; yields testable, falsifiable results (5) Results can be judged by a standard of truth (6) Public enterprise; results are reproducible (7) Not esoteric	(1) Guided by natural law (2) Explain by natural law (3) Testable, empirical (4) Tentative (5) Falsifiable	(1) Observation (2) Repeatability (3) Causality (4) Uniformity (5) Consistency (6) Comprehensiveness	(1) Grounded in Christianity (2) Distinct from theology (3) Depends on theology (4) Nature is real, ordered, valuable, regular (5) Empirical verification (6) Not teleological (7) Piecemeal research (8) Instrumental use of math (9) Mechanistic (10) Open-ended	(1) Distinct method (2) Organized effort (3) Explanations of nature (4) Subject to modification and correction (5) Systematic observation (6) Theory & research (7) Not technology, lore, skills, knowledge, techniques, crafts, or engineering (8) Linked inextricably to Christian theology

Figure 4. Although contemporary philosophers of science are skeptical of finding adequate demarcation criteria, definitions based on different perspectives are worth evaluating. Note differences between historians (Glover, Stark) and philosophers (Adler, Ruse, Geisler).

Although Adler (1965) also used dichotomies to define science, his were quite different from those of OS[2]. All three of Anderson and Geisler's (1987) defining criteria are contradicted by Adler (1965), and although they may appear to have a point of commonality in their distinction between singular and general objects of inquiry (Figure 5), Adler distinguishes the two as a dividing line between science and *other* empirical knowledge, not between different kinds of science. Given this wide divergence, what is the relationship of science to singularities? We can answer that after examining the key assertion of OS[2] that science addresses primary cause.

Primary and Secondary Cause

What about the claim that both primary and secondary cause can be scientific objects of inquiry? Primary cause(s)—defined in this context as the creative work of God—is not the proper subject of science. To understand why, we must see that "primary cause" and "secondary cause" are philosophical terms derived from theology (Figure 6). The ultimate cause of anything outside of God is His absolutely free will, executed in (1) His finished act of creation, and (2) His ongoing acts of providence, of which there are two kinds. Primary cause includes God's singular work of creation and His unique works of immediate (not mediated) providence. Immediate providence includes God's direct work, or miracles

Adler (1965)	Anderson & Geisler (1987)
INVESTIGATIVE vs. NON-INVESTIGATIVE (special experience vs. common experience)	PAST vs. PRESENT (unobserved vs. observed)
EMPIRICAL vs. FORMAL (synthetic vs. analytic)	PRIMARY vs. SECONDARY CAUSE
SINGULAR vs. GENERAL	SINGULARITIES vs. REGULARITIES

Figure 5. Comparison of the criteria for dividing knowledge between Adler (1965) and Geisler and Anderson (1987). Although their use of singular vs. general (regular) events is shared by both, the authors' use is still different.

DISCIPLINE	TERM	DEFINITION
Philosphy	Primary Causality	God's finished act of creation and His ongoing act of upholding it
Theology	Immediate Works	God acts directly to accomplish His will through creation and miracles
Philosophy	Secondary Causality	God rules creation by uniform, regular, predictable acts that we call "laws of nature." Ordinary providence.
Theology	Mediate Works	God uses created things to do His will; does not disallow immediate action

Figure 6. *Primary cause* and *secondary cause* are philosophical terms describing God's acts of creation and providence. Providence can be *immediate or mediate*. Deism was the denial of providence, based on the idea that secondary cause is innate to matter. From Reed and Williams (2011).

like the Resurrection, the Exodus, and the Flood. Both are the province of theology, not science (Reed and Williams, 2011, 2012).

Secondary cause is tied to "mediate providence" (God's work mediated through created things), and so to science, because predictable regularity in nature—i.e., uniformity—was based on the prior confidence in God's mediate providence. It was the source of the idea of "laws of nature"; the original idea emphasized the *ordainer* of the "laws," not their objects. The differences between mediate and immediate providence were captured in the medieval discussion of God's *potentia ordinata* and *potentia absoluta* (cf. Glover, 1984). Science rested on the guaranteed regularity of the *potentia ordinata*, which in turn was guaranteed by the *potentia absoluta*. Classical deism kept an abstract Creator but moved the basis for natural law from God to matter, undermining the West's appreciation of God's immanence.

Geisler and Anderson failed to mention these links and so missed aspects of the seventeenth-century mind-set, while failing to confront secularism at a point of vulnerability when they noted: "Hence it is perfectly legitimate to explain the operation of the universe in terms of purely natural secondary causes" (Geisler and Anderson, 1987, p. 26). Their qualifier "purely natural" implies something distinct from God, especially in our culture. Their shorthand may have been understood by seventeenth-century Christians but has different connotations today (Reed and Williams, 2011, 2012). God is acting everywhere, all the time. Secondary causes are "natural" only in the sense that they manifest God's *potentia ordinata*, not in the sense in which nature is the source of causation. Secularists cannot justify uniform, predictable causation without Christianity.

Since secondary causes reflect God's continuing, regular mediate providence, they are the object of scientific inquiry. Primary cause is not. Even if we posited *materialistic* primary causes, they could not be the subject of science, because the method of science assumes patterns of regularity that can be repetitively observed under controlled circumstances. Anyone can *philosophize* about such causes, but that is not science. And in the case of material primary causes, there would be no basis for a rational explanation or prediction.

The Dual Dichotomies

What about the derivation of the four sciences by the dual dichotomies of Figure 1? Singularities are discussed later, but for now, we can approach the question by examining three ways to link science to truth. These include (1) positivism, (2) OS^2, and (3) our proposal, modified from Adler (1965) and somewhat similar to Popper. Our change to Adler's (1965) idea was simply making explicit his implied theological foundation. Note that he differs from Popper by the crucial distinction between "special" and "common" experience (Figure 7).

Positivists reject theology and try to place valid knowledge under the umbrella of "science." Instead of challenging Hume's original error, proponents of OS^2 split science into distinct parts:

> Without the distinction between operation science and origin science it was believed that there is just one category for science, which is simply broadened in scope to allow origin scenarios to be considered scientific. The objective distinction between regular and singular events and the different methods used in inquiry was masked and treated as though it is a superficial difference. In fact it is a major reason philosophers of science have been unable to agree on the proper place for origin questions and on a definition of science. (Geisler and Anderson, 1987, p. 125)

But their solution sees "science" in a way similar to secularists. It differs by subdividing science. Both positivism and OS^2 grant inherent truth to science. We propose that other branches of knowledge have a place of equal respectability in their relationship to truth. Christians cannot logically affirm positivism because it is contrary to their worldview (Figure 2). For that reason, we should also reject OS^2, which sides with positivism in rejecting traditional disciplines in favor of "origin science" (as well as "historical science" and "supernormal science"), conceding primacy in origins

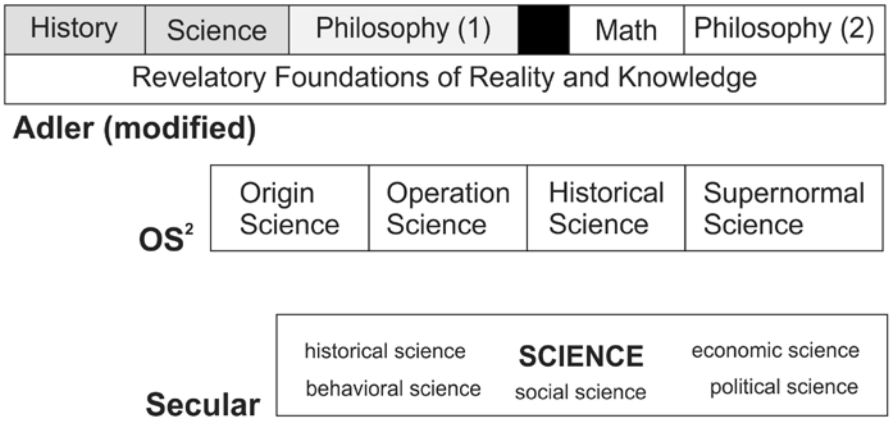

Figure 7. Three options can link science and truth. The dominant positivist view (bottom) defines all true knowledge as science. OS² (middle) distinguishes four different kinds of science based on dual dichotomies (past/ present and singular/ regular). Adler's view is modified by adding an explicit foundation of revelation. In it, first-order philosophy (1) is distinguished from second-order philosophy (2).

and earth history to something other than revelation.

Adler (1965) divided branches of human knowledge based on their distinct (1) objects of inquiry, (2) methods, and (3) questions, arguing that all disciplines were able to reach fallible truth in their own way. Adler rejected the crass positivism of his day (science = truth) by drawing a distinction between knowledge and opinion. Many (e.g. Popper, 1965, and back to Aristotle) think of "knowledge" and "opinion" as mutually distinct capacities of the mind, and today's common usage follows (Figure 8A). "Knowledge" is objective and true, while "opinion" is subjective and questionable. These are sometimes represented by the Greek terms, *epistēmē* (knowledge) and *doxa* (opinion). However, *epistēmē* in the sense of sure and certain knowledge is a slippery concept if its revelatory foundation is disallowed.

Adler (1965) redefined *epistēmē* and *doxa* (Figure 8B). He pictured subjective opinions as distinct private knowledge, separate from a spectrum of public, objective opinion, as well as from a small body of *epistēmē*. *Doxa* was not private, subjective opinion; it was fallible and conditional knowledge that could move closer to truth with increasing logical validity and/or empirical evidence. In his sense, most human knowledge (including science) is *doxa*, not *epistēmē*. When one eliminates radical skepticism by adding revelation as the underlying basis for absolute truth, Figure 7 (top) provides a good context for science. To the extent that the message of revelation is affected by human interpretation, *epistēmē* is weakened toward *doxa*; and to the extent that *doxa* is guided by *epistēmē*, it is strengthened. Building *doxa* on the foundation of positivism portends disaster (Matthew 7:26, 27), even for OS² (Figure 9).

In the Christian worldview, theology, philosophy, mathematics, history, and science can all discover limited, fallible truth but *only* because they rest on revelatory, absolute truth. That is the classic Christian position; revelation upholds all disciplines. Science is justified because its assumptions are upheld by theology, while its investigations are free to function practically without having to justify *each answer* theologically (Glover, 1984). That was the genius of the Christians who originally developed science.

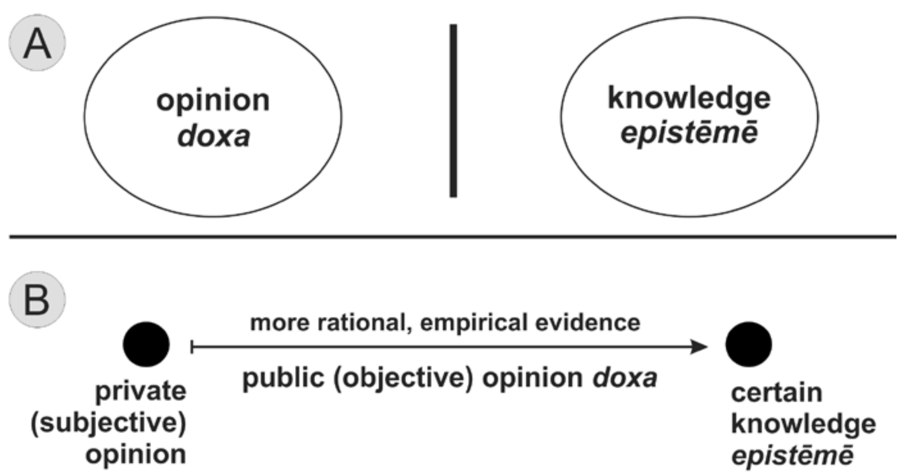

Figure 8. Knowledge and opinion are not mutually exclusive, true and false capacities of the mind (A) but can be seen as a spectrum of public increasing truth, distinct from both private opinion and sure and certain knowledge (B). See Adler (1965) for an extended discussion.

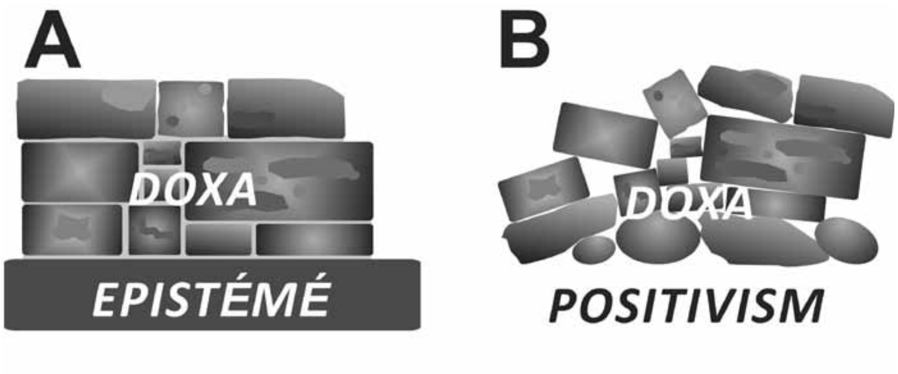

Figure 9. Revelation is the sure and certain foundation for true human knowledge (A). Positivism provides no basis for certainty, and resulting human knowledge cannot be guaranteed by absolute truth (B).

While science might appear more productive than history or philosophy, it is still one of several branches of human knowledge, all ultimately justified by biblical revelation. Absent the crass evolutionary view of Comte, there is no reason to think that truth should move in an upward progression from one branch of knowledge to another. Naturalism cannot justify science (D'Souza, 2008; Mangalwadi, 2012; Reed, 2001; Rose, 2009). But instead of asserting this directly, OS^2 sought to justify truth *within* science.

Singularities and Science

Having established that *primary cause* is not the business of science and that science must be based on a foundation of absolute truth, we turn more directly to the dual dichotomies of Geisler and Anderson (1987). One was *regularity* vs. *singularity*. They failed to make the correct theological connection. A Christian affirms the regularity of natural law because of a prior faith in divine providence, not in random interactions of matter/energy. That same faith points to God's distinct acts of creation and miracles, restricting science to truth in its own area, contrary to Hume (Glover, 1984; Reed and Williams, 2011, 2012; Stark, 2003, 2005).

That restriction invalidates their dichotomy. A synonymous dichotomy might be that between "events" and "processes." In short, science uses events to understand processes. Events are observed under controlled conditions (Adler's "special experience"). Processes are extrapolated as the same contiguous events are seen in defined conditions. Extrapolated processes become the basis for prediction of future events, and success pushes provisional *doxa* towards *epistēmē* (Figure 8). Thus, processes are validated by the successful prediction of events. But the singularities of natural history cannot work this way. Its inferred processes are not subject to special experience. Observation is indirect, and thus limited to the available data. For these reasons, it lacks the certainty of today's science.

Galileo dropping objects and timing their fall was an historical event. If you did the same, it would be a scientific test—a repetitive confirmation of Galileo's derived generalities about interactions between gravity, mass, atmospheric resistance, etc. Geisler and Anderson seemed confused by this relationship:

> Origin science is a *singularity science* about the *past*, rather than a *regularity* science which deals with a *recurring pattern of events*. (Geisler and Anderson, 1987, p. 116, emphasis added)

Past processes are not subject to the directed observation and experimentation that marks science. Scientifically, moving from a singular experience requires repetition under controlled circumstances—the essence of "special experience." Anyone can observe events and speculate about their cause, but without directed special experience, it is not science. It is instead "common experience." Likewise, Stark (2003) insisted that science was the *fusion of theory and research*.

This distinction between science and history was blurred and distorted by Lyell and the secular naturalists preceding him (Rudwick, 2005, 2008), acting on a simplistic positivist view of knowledge. Sadly, this confusion still permeates geology. However, Adler notes:

> Men who are scientists (such as geologists, paleontologists, evolutionists) sometimes attempt to establish the spatial and temporal determinants of particular past events or to describe a particular sequence of such events; but when they do so, they cease to be engaged in scientific inquiry and become engaged in historical research. (Adler, 1965, p. 107)

That is why we disagree when Geisler and Anderson state:

> This gives rise to another important distinction, that between the *object* of a scientific inquiry and the *basis* for it. The object of inquiry may be either regular or singular events. But the basis for such inquiries can only be regular conjunctions, as David Hume so forcefully argued. … Origin events are singular, and although they may be the object of scientific inquiry they can never be the basis for investigation. (Geisler and Anderson, 1987, pp. 115–116)

If "investigation" is not possible, then classifying them as objects of "scientific inquiry" begs the question. For Christians, the goal of scientific inquiry is to determine the regular patterns of God's mediate providence to better know and appreciate Him. Hypotheses that are not aimed at general rules or predictable patterns *subject to special experience* are not amenable to scientific investigation. The idea that singular events are a part of a larger pattern flows from Christian theology. So singular events of the past are not science, even though they can be investigated forensically using scientific tools (see discussion below on "mixed questions").

Some may point to forensic criminal investigations as a paradigm for the scientific investigation of the past. But this confuses the use of scientific tools used, such as DNA matching, with the essence of science as a discipline. The tools are useless until the investigator comprehends their need through a process that is not science. A DNA sample does little good if the detective cannot find a suspect to attempt a match. This is done by eyewitness testimony, knowledge of criminal behavior, or simply intuition. Likewise, practitioners of the "historical sciences" use scientific tools, but their use of prior assumptions about the past cannot be demonstrated by science (Kravitz, 2013).

True "origin events" are even more of a problem because the Christian theology that upholds science proposes a duality to God's actions. Those of creation were singular, miraculous, and complete. Being outside the "laws of nature" (mediate providence), they are outside science. We have true knowledge of them from revelation instead. The same is true of miracles. Science cannot explain the creation of light and dark any more than it can the Resurrection.

Uniformity and Uniformitarianism

Geisler and Anderson (1987) consistently mistake uniformity and uniformitarianism, undermining their attempt to justify "historical science." Lyell began the tradition of conflating the prior *principle* of uniformity with his *doctrine* of uniformitarianism:

> Lyell united under the common rubric of uniformity two different kinds of claims—a set of methodological statements about proper scientific procedure, and a group of substantive beliefs about how the world really works. … Lyell then pulled a fast one. … He labeled all these different meanings as "uniformity", and argued that since all working scientists must embrace the methodological principles, the substantive claims must be true as well. (Gould, 1987, pp. 118–119)

Recent work has been untangling this knot (Austin, 1979; Gould, 1965, 1984; Reed, 1998, 2010, 2011). But instead of evaluating Lyell critically, Geisler and Anderson (1987) accepted his work at face value and so perpetuated the error. They consistently and incorrectly defined "uniformity" as "the present is the key to the past"—making their definition of *uniformity* the cliché most associated with *uniformitarianism*! This was unfortunate because uniformity was crucial to their argument:

> At the heart of the objection to invoking the supernatural as a scientific explanation is the principle of uniformity. (Geisler and Anderson, 1987, p. 91)

After repeatedly misusing the term for most of their book, they finally note:

> There is a crucial difference between uniformitarianism and the principle of uniformity. Uniformitarianism assumes that all past causes will be natural ones like those observed in nature at the present. This is not a scientific assertion, but a philosophical one … it is philosophical naturalism. (Geisler and Anderson, 1987, p. 106)

If uniformitarianism is philosophical naturalism, then why not bring it up when they are using "uniformity" to justify "origin science"? Nor do they notice that uniformity is also a philosophical assumption.

Most practicing geologists recognize four definitions of "uniformitarianism" (Reed, 2010), of which Geisler and Anderson's (above) is but one—and it is often confused with "actualism" (Reed and Williams, 2012). Later, they persisted in incorrectly using "the-present-is-the-key-to-the-past" definition for *uniformity* (e.g., Geisler and Anderson, 1987, p. 106).

Uniformity is the idea that patterns in nature, frequently called "natural laws," operate in the same predictable manner over space, time, and (mostly) scale. When a law does not appear to "work" in a particular instance, we do not abandon it. We instead investigate for another as-yet-unknown auxiliary pattern. Uniformity is not simply at the heart of "origin science" but is at the heart of *all* science. It is the magic that transforms imperfect piecemeal observations into connected theories. Being a statement about the nature of reality, it is a metaphysical assertion, justified in the early centuries of science by Christian theology, but it remains without justification by secularists (Reed, 1998).

The primary question, then, is not what uniformity is but why we should believe it. Kravitz (2013) notes that it functions as wishful thinking for most geologists, justifying a past that cannot be demonstrated. Empirical observation cannot justify uniformity. Metaphysical statements require metaphysical justification, and uniformity was initially tied to the nature of God. Secularists raised in a Christian culture are content to use Christian presuppositions, even though they believe the worldview is false.

Geisler and Anderson (1987) defined "uniformity" incorrectly. They neglected the future half of the temporal dimension, as well as dimensions of space and scale. A poll of geologists would likely return 100% identifying "the present is the key to the past" with *uniformitarianism*. If uniformity is essential for "origin science," then why define it in such a cavalier fashion?

Furthermore, Geisler and Anderson (1987) missed out on an opportunity to advance the Christian worldview by pointing out the inconsistencies in uniformitarianism. Secular geologists, seeing these inconsistencies in the critiques of Hooykaas (1963) and Whitcomb and Morris (1961), scrambled to salvage the concept by splitting it into four definitions, and Reed (2010, 2011) showed the problems in these. Cleaning up Lyell's mess is not done by accepting his false premise and positing "origin science" or "historical science" but by showing that science itself is consistent—and only consistent—with the faith system that uniformitarianism attempts to undermine.

OS^2 fails to see that (1) uniformity is essential to any science, not just "origin science"; (2) it is not defined simply by *past* and *present* but includes the future, as well as dimensions of space and scale; (3) it is not the same thing as uniformitarianism; and (4) it is justified *only* by Christian theology, though it continues as an axiom of secular science. The final point should be the opening of an apologetic attack, not a concession that "origins" is a science.

How Did Science Develop?

Correcting the distorted secular history of science has been an ongoing task since the groundbreaking work of Pierre Duhem (1861–1916) in the early twentieth century (cf. Aeschiliman, 2013; Glover, 1984). While Geisler and Anderson (1987) affirmed the Christian roots of science, their analysis was limited, and secular myths permeated their book. They infer a seventeenth-century "scientific revolution." However, evidence suggests a more gradual development from the medieval explosion of universities in Europe. Their error likely stemmed from a prior acceptance of the division of history into a classical "golden age," the obscurantist Christian "dark ages," and a secular "renaissance" that overthrew "religious superstition." For example, they claimed:

> Despite significant theistic influences on science, scientists were acutely aware that authoritarian religious control can stifle inquiry, and they sought to be free of such influence. (Geisler and Anderson, 1987, p. 112–113)

We now know that science was nurtured by the church; it was less a source of "authoritarian control" than many other social institutions. Also, historical context is important. What we would call "authoritarian control" today was accepted social structure centuries ago. The real "authoritarian control" has come not from the church but from *secular* governments (Day, 2008) and academia (Bergman, 2008).

Geisler and Anderson misunderstood the cultural context of the seventeenth century:

> In the seventeenth century a Greek view of reality dominated the intellectual world. An essential facet of Greek science was that the world is a living organism impregnated with divinity and final causes. (Geisler and Anderson, 1987, p. 112)

But seventeenth-century Europe had a *Christian* view of reality. There were elements of Greek thought, but these were not dominant. Scholastics had rigorously subjected Aristotle to a Christian critique, and points of essential conflict were resolved *in favor of the Bible*. The uniquely Christian university system created a network of Christian knowledge that was the seedbed of science. Glover (1984), Hooykaas (1972, 1999), Stark (2003, 2005), D'Souza (2008), Mangalwadi (2012), and many others affirm that science grew out of a Christian worldview, not a Greek one.

Geisler and Anderson also missed the theological sophistication of the seventeenth century. When they stated, "These men were interested in learning by experience how the world works, not why it exists and what higher purposes might be involved" (Geisler and Anderson, 1987, p. 111), they make it sound as if the Reformation never happened. The seventeenth century was dominated by practical outworking of competing theological issues; it was the century of Protestant creeds like the Westminster Confession and Catechisms, convened by England's Parliament. Likewise, Lutheran theology grew in Nordic and German states, and other Protestant traditions were seen in the Huguenots in France, and the Puritans in America. Wars and revolutions were fought between Catholics and Protestants, not between Christian and Greek philosophers. As late as 1754, Jonathan Edwards could enhance his scholarly reputation in Europe by writing a theological dissertation arguing that God created the universe to demonstrate His glory. As some have noted (Bartz, 1984; Hooykaas, 1999), men of that time saw nature through the lens of God's providence. Miracles were not few and far between; as Hooykaas noted, *everything* was a "wonder."

Exacerbating this mistake, Geisler and Anderson anachronistically assumed that seventeenth-century thinkers used twentieth-century categories of "origin" and "operation" science:

> Nevertheless, there seemed to be little or no appreciation of the difference between *singularity science* and *regularity science* … The process began with Descartes, who talked mostly of *operation science*. (Geisler and Anderson, 1987, pp. 112, 114, emphasis added)

Scientists then had no need of these categories. They took for granted the Christian foundation for science and distinguished it from history and metaphysics. Today's struggles were unknown, despite the concerns of Geisler and Anderson:

> In order to avoid the charge that they were making science religious

> early scientists sorely needed a way to legitimately handle the connection between their belief in a creator and the new science. (Geisler and Anderson, 1987, p. 113)

Scientists in the seventeenth century already had a way to "legitimately handle" their belief in Creation. It was called "theology," and it was congruent with their science. Modern man has been so influenced by secularism that it is hard to realize that there was once a time when theology and science were simply two conjoined aspects of human knowledge. One need only read works from that period to see how seamless that relationship was.

Methodological Naturalism?

Secularism has often succeeded by equivocation (Doyle, 2012). Especially effective has been the use of the term "naturalism." Although opposed to "philosophical" naturalism, many Christians, including Geisler and Anderson (1987), give it life by accepting the corollary that "methodological" naturalism is a part of science. Secularists insist that science restrict itself to strictly natural causes, with the implied premise that these causes are inherent to matter and energy:

> The creationist is wrong in positing a supernatural cause for any regular repeated event in nature, for a regularly recurring pattern of events necessitates a natural explanation. (Geisler and Anderson, 1987, p. 105)

In effect, Christians must leave God at the laboratory door, contrary to 1 Corinthians 10:31. This secular semantic deception promotes confusion. Christians must wade through the tangled multiple meanings of "naturalism" (Reed and Williams, 2011). Today, even terms like "natural law" imply an atheistic view of nature. Ultimately, this leads to theological error:

> The reason for this [astronomers not finding first cause] is simply that "knowledge of the creation is *not* knowledge of the Creator…" That is to say, operation science by its very nature is limited. It can provide insights into the operation of the universe by secondary natural causes, but cannot offer insights about the origin of the universe. (Geisler and Anderson, 1987, p. 27)

The Bible disagrees, most famously in Romans 1 and Psalm 19. God *is* known through what has been made, and they should have known it.

The answer to methodological naturalism is the doctrine of providence. The biblical God "[upholds] all things by the word of his power" (Hebrews 1:3 KJV). He controls nature *all the time*, not just occasionally with a rare miracle. Both primary and secondary cause point to God because only God justifies a view of causality that justifies science (Reed and Williams, 2012). If methodological naturalism is a prerequisite of science, then how did early scientists, steeped in the Christian worldview, succeed? They derived all of the essentials of the scientific method without it. When the authors of OS[2] endorse "methodological naturalism," they undercut their opposition to philosophical naturalism.

The "God-of-the-Gaps" Fallacy

Geisler and Anderson (1987) also seem to accept the "god-of-the-gaps" fallacy. Secularists have long claimed (per Comte) that "natural" science displaced theology because it gradually provided superior natural explanations (so the story goes) for phenomena previously attributed to providence. Using this template, secularists claim that Christians use God to explain the "gaps" in natural understanding. They hope that this imaginary trend will render God completely irrelevant.

The "god-of-the-gaps" idea was effective propaganda, allowing increases in human knowledge to automatically push people toward atheism. The most surprising aspect of this canard is that *Christians* would accept it. Christians are diverted by their innate belief in truth and respect for science. It has reduced many to silence. Thaxton et al. (1984) and Geisler and Anderson (1987) all fell for the basic argument:

> Basically the idea of the God hypothesis is that whenever there is a gap in our knowledge, we run God in as a "bit-player," so to speak, to fill the gap. This view is known fittingly as the God-of-the-gaps. There is legitimate concern about this means of solving problems in operations science. (Thaxton et al., 1984, p. 203)
>
> Citing God's special intervention to explain regularly recurring events is to argue for a deus ex machine; it is an illegitimate God-of-the-gaps move. (Geisler and Anderson, 1987, p. 17)

They failed to understand that the "god-of-the-gaps" accusation is easily answered by challenging the assumptions of the accusers. Because the West was monolithically Christian for so long, believers were slow to appreciate that secularists were not neutral; they have an agenda to "suppress the truth in unrighteousness" (Romans 1:18b NASB). Having hijacked science, they want to keep God out, and the "god-of-the-gaps" accusation derails Christians who start asking inconvenient questions.

As Weinberger (2008) explained, the argument works only if a *deistic* god is assumed, reality is a natural causal continuum, and divine action is "interference." This is why the doctrine of providence is so important; it teaches us that the ongoing operation of the cosmos is ultimately divine. There is nothing to "disturb"; God is already in charge. The argument also confuses epistemology and metaphysics. Gaps in our knowledge do not necessarily reflect gaps in the fabric of reality. Human limits are a sufficient reason for epistemological "gaps."

Reed and Williams (2011) noted that one key to refuting this argument is uniformity. As a precondition for science, it cannot be justified by naturalism. That is because it rests on a continuity of cause and effect, which in turn rests on a transcendent, infinite, eternal, and unchanging God. Christian theology makes the accusation meaningless. If Thaxton et al. (1984) and Geisler and Anderson (1987) had remembered this, they might have provided a more effective argument against positivism. If you want causality and uniformity, then you must take God in the deal. Secularists cannot have it both ways.

Conclusion

Although superior to the pure positivism of naturalism, the Christian alternative of OS^2 advocated by Geisler, Thaxton, and Anderson is not a satisfactory alternative. It did point to a needed emphasis on the history and philosophy of science, but it failed to follow those trails to the proper conclusions. Since science is the child of Christianity, its axioms are justified only by a biblical worldview. This requires more fundamental revision than OS^2.

Furthermore, the idea is flawed in several key areas. Its attempt to divide science into different disciplines to study both primary and secondary causes is shortsighted because science is methodologically incapable of investigating primary cause. Philosophy and theology are better suited to answer metaphysical questions. OS^2 is built on dual dichotomies (*past/present* and *regularity/singularity*) that do not provide a sufficient foundation for science. Geisler's (1983) criteria for "origin science" fail to distinguish that proposed science from any other investigative branch of human knowledge. Finally, OS^2 fails to address the problem of positivism in aggressively biblical categories, especially the relevant doctrines of creation and providence.

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The Little Ice Age in the North Atlantic Region

Part VI: The Little Ice Age and Climatology

Peter Klevberg and Michael J. Oard*

Abstract

Earlier papers in this series introduced methods of studying past climate change, the historicity of the Little Ice Age as well as the Medieval Warm Period, the importance of the Little Ice Age in understanding climate change and constraining climatic models, and the importance of the North Atlantic region in understanding and applying constraints on climatic and glacial models. Earlier papers included summaries of the effects of the Little Ice Age in Iceland, Norway, and Greenland. This paper presents an analysis of how the Little Ice Age climate-change record should constrain paleoclimatology and speculations on potential climatic-forcing mechanisms.

Constraints Provided by the Little Ice Age

Natural science plays a corrective role, not a creative role, in natural history studies (Reed and Klevberg, 2011). Science deals with the observable present, not the unobservable past and therefore plays the invaluable role of testing the predictions of historical hypotheses. This is the beauty of the Little Ice Age; while climate-change scenarios may proliferate, replete with computer models and even propaganda films, we have in the Little Ice Age historic data that can be used to discount those models that stray far from reality.

As can be seen from Figure 1, even reconstructions of the single climatic variable of average Northern Hemisphere land surface temperature over the past millennium results in a variety of models. How much more widely might "ancient ice age" models deviate from reality? As we have sought to stress throughout this series, climatic inference is just that—inference about history, not scientific observation. There is only so much that can be ascertained from study of proxies in the present. Thus, even among researchers whose worldviews and personal biases are similar, there are sometimes very different conclusions, as shown in Figure 1. As documented in Part I of this series (Klevberg and Oard, 2011a), this results from different data sets, different weighting of those sets, different approaches to statistical analysis, and plain speculation. This is the difficulty with paleoclimatology.

Paleoclimatology is important to us for several reasons. An obvious one is the degree to which we should fear anthropogenic climate change (Gore, 2006) and its political ramifications (e.g., carbon taxes). In science, the primary application of data from the Little Ice Age is to provide constraints on a Great Ice Age and the geologic effects inferred to have been caused by it. Those topics

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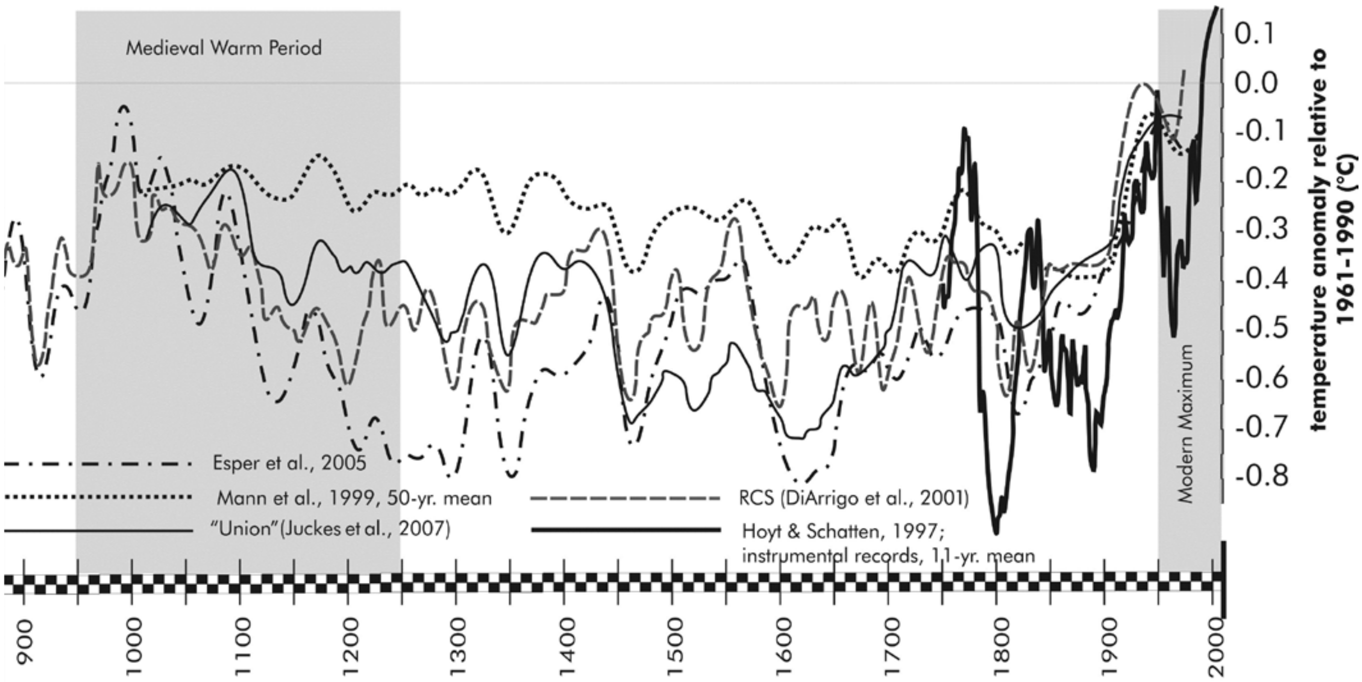

Figure 1. Considerable variability is evident between different reconstructions of Northern Hemisphere land surface temperatures over the past millennium.

will be addressed in the final two parts of this series. This paper addresses possible climatic mechanisms for the Little Ice Age.

Global warming alarmists have tended to play down the Little Ice Age (Klevberg and Oard, 2011b), and an inaccurate explanation of the Little Ice Age will be compounded in evaluating speculations regarding the Great Ice Age. It is therefore important to gain the most accurate understanding possible of the Little Ice Age first.

The Mann et al. "Hockey Stick"

As was outlined in Part I of this paper, modeling past climate is neither simple nor straightforward; much room is available for the influence of bias and subjective elements. In the case of the well-known Intergovernmental Panel on Climate Change (IPCC) "hockey stick" Northern Hemisphere temperature reconstruction (Mann et al., 1998, 1999), these biases include, of course, uniformitarian presuppositions and reliance on uniformitarian-based dating methods, but also a particular opinion on the likelihood of greenhouse-gas-induced global warming. Most creationists are well acquainted with the tendency of science to be hijacked by political or religious causes, such as evolutionism (cf. appendix). The proxy data used for this controversial temperature reconstruction probably differ more by data type than by source region, though this does not appear to be clearly stated by the author (Mann, 2002).

While criticisms of the Mann/IPCC "hockey stick" by McKitrick (2005) and McIntyre and McKitrick (2003) have been substantiated (Briffa and Osborn, 2002; Guiot et al., 2005; Juckes et al., 2007), follow-up work by Mann and others has not resulted in large-scale changes to the result (Mann et al., 2004). Use of the climate field reconstruction methods answers at least some of the criticisms of McIntyre and McKitrick, as spatial coverage is very important (Esper et al., 2005; Guiot et al., 2005; Juckes et al., 2007; Luterbacher et al., 2004; Rutherford et al., 2005; von Storch and Zorita, 2005). As mentioned in Part I of this series, use of the chronology from the CO_2-sensitive bristlecone pine (cf. Figure 2 in Mann, 2002) may have been a significant factor in generating the "hockey stick" curve of Mann et al., as may choices in transfer function creation (Esper et al., 2005; Juckes et al., 2007). The dismissal by Mann and Jones (2003) of the "flawed study" by Soon and Baliunas (2003) is, in our

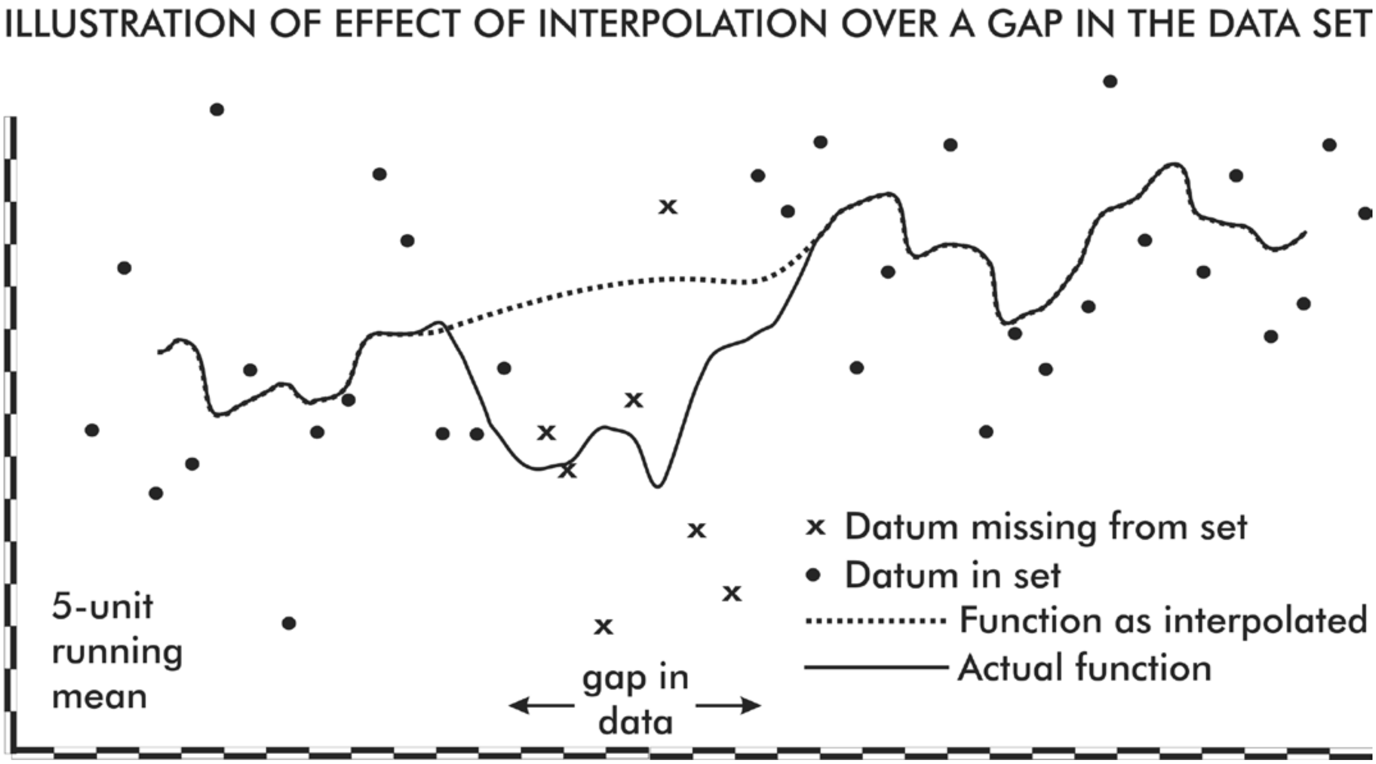

Figure 2. A gap in data can lead to serious errors in paleoclimatic reconstruction. This becomes more of a problem back in time, when data sets are fewer and less complete.

opinion, at best inadequate, and their study clearly justifies more than such a nonchalant dismissal. Newer work indicates refinements in technique that may alter earlier reconstructions (Christiansen and Lungkvist, 2012). There is no "consensus" here.

Of particular concern for any model purporting to reveal the effect of atmospheric CO_2 on climate change is the use of the CO_2-influenced portion of the instrumental record for calibration of the model. This is not an easy problem to solve, as the instrumental record available for calibration and verification is mostly limited to the period of time during which carbon dioxide concentrations were increasing. It may be neither possible nor necessary to account for this in the models if the greenhouse gas concentrations are responding primarily to natural changes, but neither would it be possible to tell if that is the case.

History versus Science

Not uncommon are news reports of individuals who have been incarcerated for years and then exonerated based on DNA evidence. Many have been exonerated or convicted based on forensic evidence, yet how such evidence can be manipulated is the stuff of crime novels and movies. Forensic evidence can be invaluable in discrediting untrustworthy witnesses, but it must not be used without them (Deuteronomy 17:6). Science is a useful servant to history, but cannot replace it.

Mortimer Adler, one of the foremost philosophers of science, pointed out long ago that science and history operate under distinctly different rules of investigation (Adler, 1965). These differences are shown in Table I. Paleoclimatology and historical geology, which deal with the unobservable past, are therefore branches of history (albeit using scientific technology). Why, then, has the scientific establishment worked so hard to blur this distinction? Why have historians sought to make their discipline an "empirical science" (Windschuttle, 1997)? William Morris Davis, the highly influential American geologist, promoted the replacement of scientific (descriptive and classificatory) terminology with historic (genetic) terminology and origins stories (Davis, 1954). These issues have been addressed elsewhere on a foundational level (Reed, 2001, 2005; Reed et al., 2004, 2006; Reed and Klevberg, 2011).

Whether researchers recognize these methodological differences will be reflected even in the data acquisition phase, as was pointed out in Part I of this series (Klevberg and Oard, 2011a). An element of judgment also enters into the weighting of the data that are selected. Thus, the models that result may deviate significantly from reality. How this has occurred in paleoclimatology and current climate modeling will be shown in this paper against the backdrop of the Little Ice Age.

Table I. Differences between historical and scientific methods.

Science	History
ongoing	unique
repeatable	unrepeatable
directly observable	not directly observable
primarily inductive	primarily deductive
relies principally on measurement/observation	relies principally on testimony/observer
failure to recognize limits leads to distortion and faulty conclusions	failure to recognize limits leads to distortion and faulty conclusions

Limitations of Modeling

Computer models are nothing magical. Models, computerized or not, are simply organized collections of thoughts of how things may behave under certain conditions. They are therefore dependent on the quality and quantity of the data employed, as well as the way those data are interpreted.

Limitations from Data

The natural limitations in proxy data available were mentioned in Part I of this series. However, there is another type of data limitation that arises from the nature of historical study. This is illustrated by Figure 2. The problem can be severe if the discontinuous variable occurs either wholly within or wholly outside the calibration + verification period.

Limitations of Analysis and Modeling

Some have recognized the limitations of climatic modeling (Frauenfeld, 2005; Friis-Christensen and Svensmark, 1997; Oard, 2009; Soon et al., 1999). Legates (2005, p.144) lists these limitations: (1) incomplete understanding of the climate system, (2) coarse resolution, (3) inability of models to reproduce many vital phenomena, and (4) interconnected nature of the climate system.

On predicting climate responses to CO_2, CH_4, O_3 and aerosols, Posmentier and Soon state, "A logistically feasible validation for such predictions is essentially inconceivable." They continue, "It follows from Oreskes et al. that the intrinsic value of a climate model is not predictive but heuristic or educational, helping to add to knowledge without providing conclusive fact" (Posmentier and Soon, 2005, pp. 243, 244). This may be illustrated (heuristically) relative to carbon dioxide, where cause and effect are not clearly distinguishable (Figure 3).

Limitations from Bias

The role of bias in the selection and weighting of proxies was outlined in Part I of this series. A great deal of judgment is necessary in evaluating proxy data, determining the degree of smoothing to use, inferring confidence intervals, choosing regression algorithms, constructing neural networks, etc. Any model will necessarily express the bias imparted by its proxy data and the transfer functions derived from them, as described above for the Mann et al. "hockey stick."

Ogilvie and Jónsson (2001) make the important point that proxies have largely been calibrated to rising temperatures; other relationships might exist if proxies were calibrated to falling temperatures. Common warming trends from the mid to late Little Ice Age to the late 1900s and present decade have been in the range of 1.5°C in the Baltic countries (Tarand and Nordli, 2001) to 4°C in Iceland (Grove, 2001). Estimated temperature changes outside our study area appear generally to agree with these long-term warming data (e.g., New Zealand more than 1°C, New Guinea approximately 1°C, per Grove, 1988). Popular climate models that indicate changes over the past millennium of 1°C or less are thus almost certainly wrong.

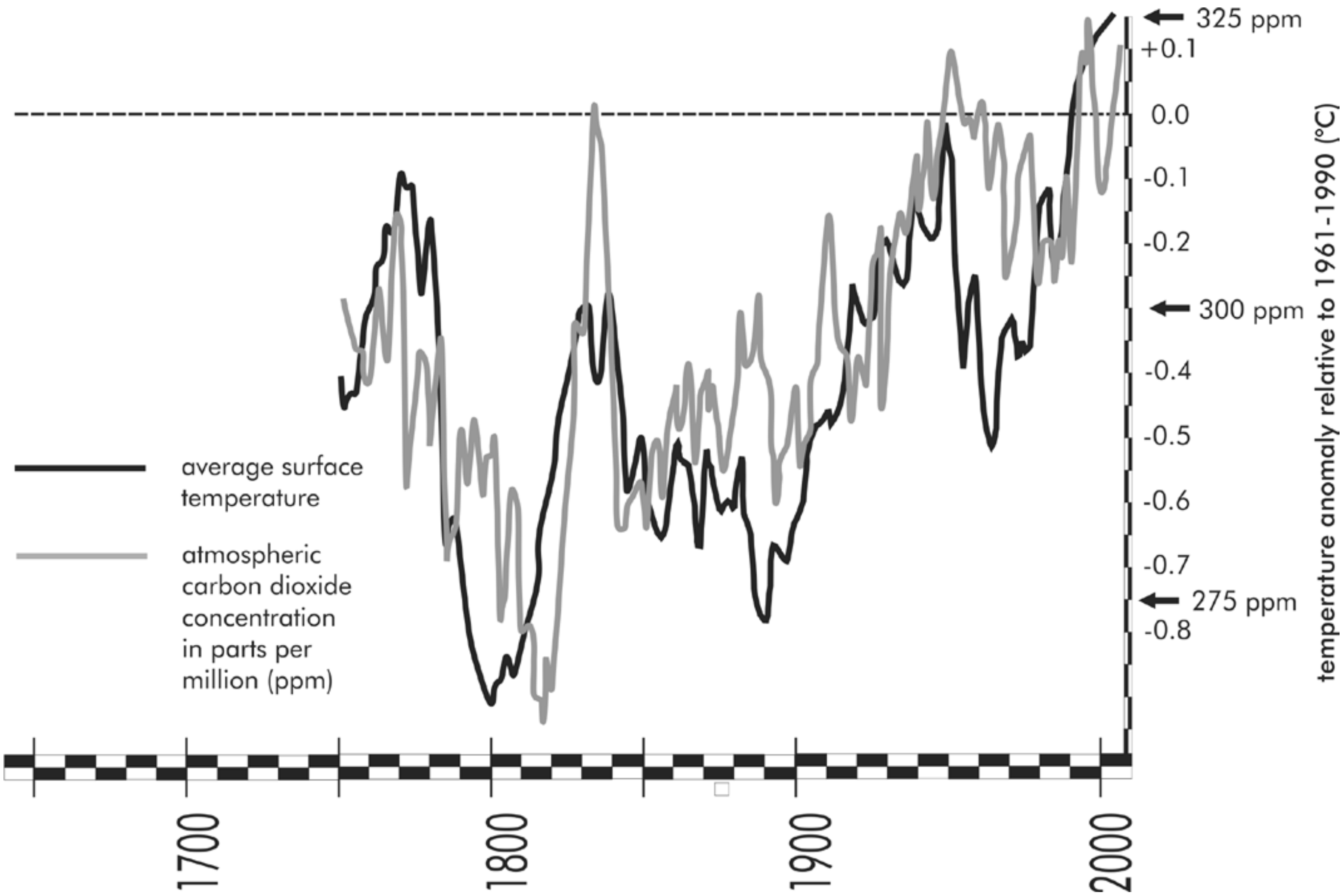

Figure 3. The instrumental temperature record for Northern Hemisphere land temperatures and atmospheric carbon dioxide concentration. The increase in carbon dioxide has largely occurred since the end of the Little Ice Age. What is cause, and what is effect? Warming temperatures cause release of carbon dioxide from oceans and soils, which in turn causes atmospheric warming, which releases more CO_2 into the atmosphere. Data compiled from Briffa and Osborn (2002), Hoyt and Schatten (1997), and Juckes et al. (2007).

Limitations from Regional and Feedback Effects

Another limitation in climatic modeling is spatial bias introduced by the locations of the observations. The "urban heat island effect" is a well-known example of this, but it is far from the only one. On top of biases introduced by weather monitoring point layout are regional feedback systems in the atmosphere and oceans.

The North Atlantic Oscillation

In the North Atlantic Ocean, permanent low pressure is centered over Iceland (the Icelandic Low), while a permanent high-pressure area is centered over the Azores (the Azores high). Oscillations in the strength of the pressure difference between the Icelandic Low and the Azores High influences the weather in Europe. Since westerly winds are proportional to the north-south temperature difference, the stronger the pressure difference, the stronger the westerly winds. A positive North Atlantic Oscillation (NAO) is an above-average pressure difference, while a negative NAO is a pressure difference below average (Figure 4). The NAO varies from year to year, and it especially affects winter weather. A positive NAO, with a strong pressure difference and strong westerly winds, causes cooler summers and mild, wet winters in northern Europe but dry winters in southern Europe. A negative NAO results in weak westerly winds, hot summers, and cold winters in northern Europe, but the storm track is diverted south with more storms in southern Europe and North Africa.

The NAO also affects the weather in eastern North America. A positive NAO results in more southwest winds with a milder, wetter winter. A negative NAO

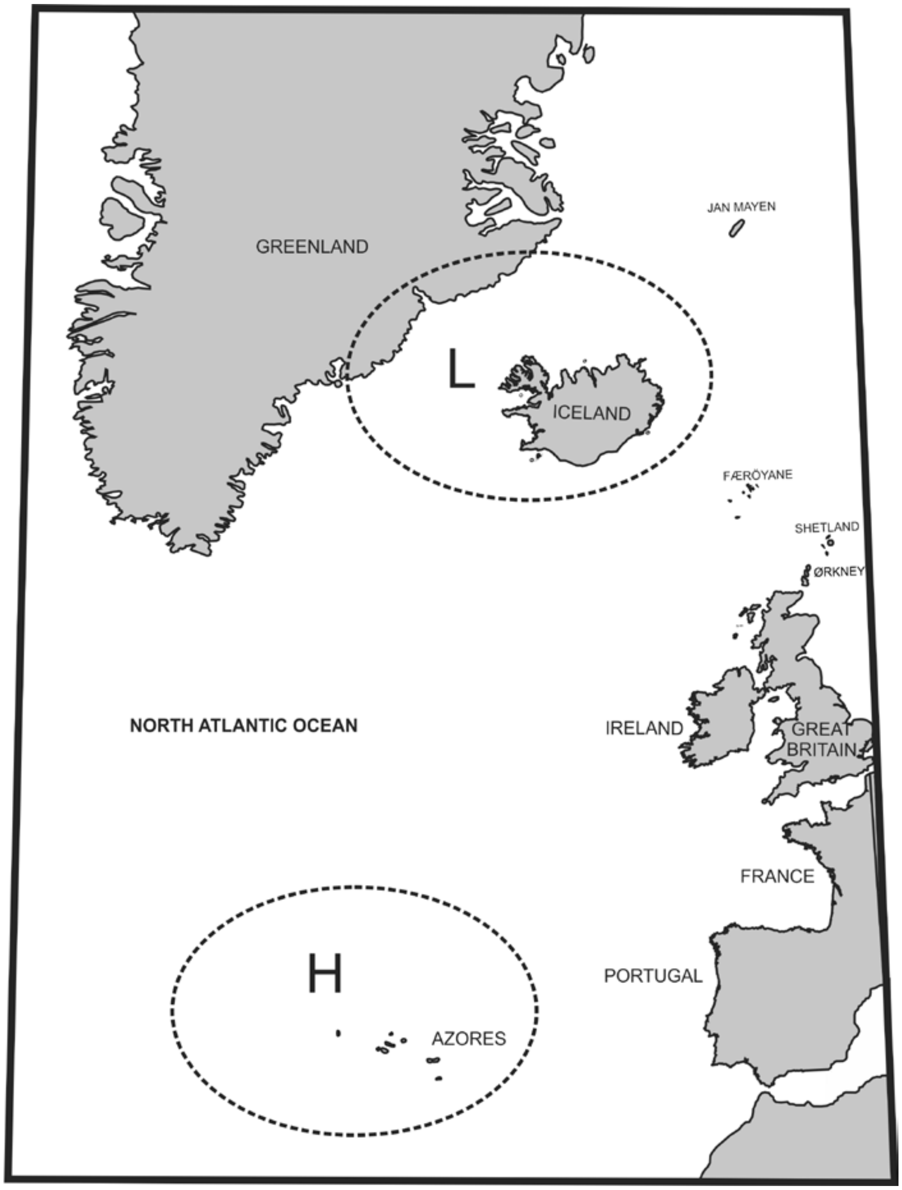

Figure 4. The North Atlantic Oscillation in normal position. A negative NAO has high pressure over Iceland and low pressure over the Azores. The NAO can explain variations within the Little Ice Age but not the event itself.

causes more cold Arctic outbreaks and heavier snow in winter.

The NAO is believed to be caused by sea surface temperature (SST) anomalies (Rodwell et al., 1999). The temperature of the ocean changes slowly and is believed to affect the atmosphere: warm SSTs result in a warmer atmosphere and more high pressure aloft, while cold SSTs cause a cooler atmosphere and lower pressure aloft.

The NAO has been given considerable weight by some as a potential explanation for much of the climatic deterioration of the Little Ice Age (Fagan, 2000). It has been strongly correlated with winter precipitation in Norway (Bjune et al., 2005). In general, the NAO produces a "seesaw" effect between Greenland and Europe (Barlow, 2001; Fagan, 2000). However, despite the arguments of some (Mann, 2002), it cannot explain the Little Ice Age itself but only the complexities of the decade-scale variations within it (Barlow, 2001; McKinzey et al., 2005). Attempts at reconstruction of the NAO using proxies have had limited success (Jevréjeva, 2002; Luterbacher, 2002). If the global average temperature increase is real, then the NAO cannot be used to explain away the Little Ice Age any more than the present cooling of Greenland denies global warming (Hansen, 2006). The NAO likely does not cause any net changes for the region as a whole nor for the whole earth.

The El Niño—Southern Oscillation

The El Niño-La Niña phenomenon in the South Pacific Ocean is a well-known teleconnection similar to the NAO. Like the NAO, the El Niño-Southern Oscillation (ENSO) can explain decadal-scale variation but not long-term climatic shifts like the Little Ice Age (Frauenfeld, 2005). The NAO and ENSO may be thought of together as the Arctic Oscillation, and the dominant mode of the Arctic Oscillation appears to respond much more strongly to intensity changes in solar ultraviolet radiation than to concentration of greenhouse gases (Frauenfeld, 2005).

The Pacific Climate Shift

In 1976–1977, an apparent increase in ENSO frequency occurred that remains to this day, as does the mystery of its explanation (Frauenfeld, 2005). Meanwhile, the NAO paralleled the increase in greenhouse gas concentrations until the mid-1990s, after which it decoupled and went negative. "But the time series itself is nonlinear and, especially in light of the NAO's negative departures during the late 1990s, such linear trend descriptions are as meaningless as the global warming implications they are purported to support" (Frauenfeld, 2005, p. 163).

Other Regional and Feedback Effects

Barlow (2001, p. 109) states that about 40% of mild winters in Europe result from westward displacement of the Siberian Anticyclone rather than the North Atlantic Oscillation. Interactions between the Baffin Trough and Iceland Low are important to temperature trends between Iceland and Greenland. Good correlations between seasonal weather anomalies, the Central European Zone Index and the NAO Index about a century ago have not continued in more recent decades (Jacobeit et al., 2001). A complex relationship between the NAO and atmospheric patterns over the Mediterranean, North America, and the Pacific are postulated (van Loon and Rogers, 1978, 1979; Wallace et al., 1995). All of these represent regional and relatively short-term mechanisms that add to the complexities of the Little Ice Age, but do not explain the ice age itself.

Possible Climatic-Forcing Mechanisms

The two obvious choices for driving climate change are volcanism and changes in insolation (solar radiation striking the earth). Volcanic eruptions are generally understood to result in a net cooling of the earth. Changes in solar irradiance (i.e., the rate of radiative energy given off by the sun) could cause warming or cooling of the earth relative to the average value, as well as interacting with other climatic variables. In recent years, the potential role of greenhouse gases has been emphasized. Major forcing mechanisms are summarized in Table IV.

Volcanism

It is well established that volcanism causes cooler temperatures on the earth (Oard, 1990; Salzer and Hughes, 2007), at least initially. There are, of course, a number of other variables related to the temperature change, such as the intensity of the eruption, frequency of eruptions, how much SO_2 reaches the stratosphere, the season of the eruption, the latitude of eruption, and the state of the climate system during eruption (e.g., whether El Niño is occurring). Major volcanic eruptions are listed in Table II and indicated on Figure 5.

"There seems little doubt that volcanic activity influences climate but the extent of this influence is controversial" (Grove, 1988, p. 368); the great Krakatau (a.k.a. Krakatoa) eruption, for example, produced no observable glacial advance. The eruption of Mount Pinatubo in 1991 produced tropospheric cooling of 0.7°C and surface cooling of 0.4°C, but was short-lived (Christy, 2005). Volcanism can cause winter warming of mid and high latitudes by causing more storminess and mixing of the air, retarding the formation of inversions, but the net yearly temperature change is colder temperatures. The sulfur aerosols in the stratosphere produced by the volcanism usually affect climate for only a few years but can last up to about ten years. These aerosols can have a greater effect than ash in producing cooling (Bardintzeff and McBirney, 2000). It is believed that pulses of volcanic activity substantially contributed to the decadal-scale climate variability of the Little Ice Age (Ammann and Naveau, 2003; Salzer and Hughes, 2007). In combination with atmospheric feedback mechanisms like the NAO, volcanism may account for over half this variation (Christy, 2005). However, others point out the complexities of volcanism and feedback mechanisms (Sadler and Grattan, 1999), sometimes postulating a net *warming* (Robock, 2000). Some have pointed out that atmospheric aerosols can have a moderating effect on climate (Fan et al., 2008).

Solar Irradiance

Although changes in volcanic aerosols in the stratosphere have a significant influence on climate, the effect is on the short timescale–approximately a decade. Strong volcanic eruptions occurred during the Little Ice Age, including Tambora and Lakí. However, the Little Ice Age lasted half a millennium, so a long-term mechanism is required. Krakatau, one of the most significant eruptions, occurred at approximately the end of the Little Ice Age, so volcanism alone cannot explain the long-term climate change.

Ultimately, virtually all of our earth's warmth comes from the sun. Without it, Earth's interior warmth would radiate to space and the surface would become very cold. The greater question to climatology is to what extent the subtle variations in the amazingly stable solar irradiance may induce terrestrial climate change. There is a long-term natural forcing of climate that appears to correspond with changes in solar irradiance (Loehle and McCulloch, 2008). The amount of insolation has long been considered a constant; in fact, it was called the "solar constant." We now know that insolation varies a slight amount, and this slight amount is correlated to temperature variations on the order of a few degrees Fahrenheit. The intensity of the solar irradiance varies with the number of sunspots: a high number of sunspots corresponds with increased insolation and warmer terrestrial surface temperatures, and vice versa. This seems counterintuitive, since sunspots are cool areas relative to the rest of the surface of the sun, but the sunspots are more than balanced by faculæ (Foukal, 2003)—hot spots of increased irradiance. There is an 11-year periodicity in sunspots, and many atmospheric scientists believe this cycle can be correlated with climate (Scafetta and West, 2008). But there are also longer-period fluctuations, and it is these longer cycles that are of particular interest to the question of what caused the Little Ice Age (cf. Figure 5).

Sunspots have been recorded ever since the telescope was invented. In general, there were relatively few sunspots during the Little Ice Age, while there has been a relatively large number since (Figure 5). During the Little Ice Age, five periods of especially low sunspot frequency were observed (Table III), the most notable being the Maunder Minimum between 1645 and 1715 (Figure 5). This was also the most intense time of the Little Ice Age (Fagan, 2000). The trend in sunspot number, and thus insolation, appears to provide the best correlation for the long-term

Table II. Major volcanic eruptions over the past thousand years. Data from de Boer and Sanders, 2002; Robock, 2002; Sigurdsson, 2000; Ward, 2009.

SUMMARY OF MAJOR VOLCANIC ERUPTIONS					
Volcano	**Country/Region**	**Date**	**V.E.I.***	**Ejecta (km^3)**	**Latitude**
Eldgjá	Iceland	934			64.4N
Changbaishan	China	1000	7	96	
Quilotoa	Ecuador	1280	6	21	0.8S
New Hebrides	Vanuatu	1399	?	36–96	16.7S
Barðabunga	Iceland	1477	5+	12.5	64.6N
Bouganville	New Guinea	1580	6	14	6.1S
Huaynaputina	Peru	1600	6	30	16.6S
Santorini	Greece	1650	6	60	36.4N
Long Island	New Guinea	1660	6	30	5.4S
Lakagígur	Iceland	1699	6	14	64.4N
Tambora	Indonesia	1812	7	150–160	8.2S
Ksudach	Russia	1822	6	18–19	51.8N
Cosiguina	Nicaragua	1835	5	5.7	13.0N
Askja	Iceland	1875	5		65.0N
Krakatau	Indonesia	1883	6	20–21	6.1S
Okataina	New Zealand	1886	5		38.1S
Santa Maria	Chile	1902	6	5.5–20	14.8N
Ksudach	Russia	1907	5	2	51.8N
Novarupta	Alaska	1912	6	28	58.3N
Cerro Azul	Chile	1932	5+	9.5	0.9S
Bezymianny	Kamchatka	1955	5	2.8	56.0N
Agung	Indonesia	1963	5	1.1	8.3S
Mt. St. Helens	Washington	1980	5	1.274	46.2N
El Chicon	Mexico	1982	5	2.3	17.4N
Hudson Cerro	Chile	1991	5	4.3	45.9S
Pinatubo	Phillipines	1991	6	11	15.1N

*Volcanic explosivity index

Data from Sigurdsson (2000), Bardintzeff and McBirney (2000), Robock (2002).

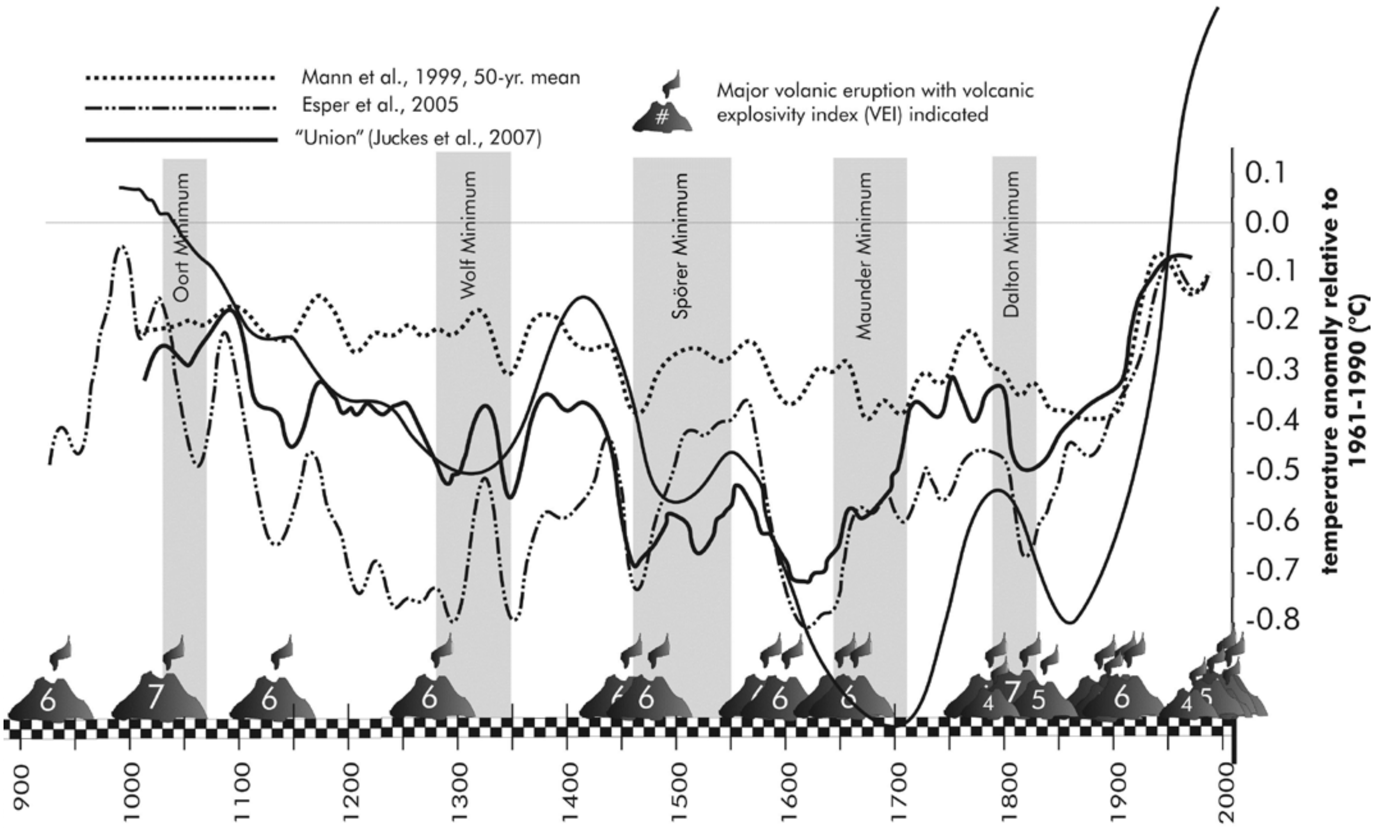

Figure 5. Some well-known temperature reconstructions shown with solar minima and notable volcanic eruptions, the two most probable forcing mechanisms for the Little Ice Age.

trends of the Little Ice Age; volcanism only accounts for short-term variations in global temperature (Ammann and Naveau, 2003; D'Arrigo et al., 2001; Fagan, 2000; Lean et al., 1995; Pang and Yau, 2002). Comparisons of ^{14}C and ^{10}Be provide a proxy for solar irradiance, and cycles on the order of a decade (Schwabe Cycle), a century (Gleissberg Cycle), two hundred years (deVries or Suess Cycle), and longer have been identified (Baliunas, 2005).

Overall, changes in solar irradiance appear to explain about half of the global temperature variations observed (Baliunas, 2005; Balling, 2005), and even global warming proponents generally acknowledge it as an important variable (Mann et al., 1998), though some have disputed any important role for this variable (Gore, 2006; Mass and Schneider, 1977). The solar cycle appears to no longer dominate after 1990 (Thejll and Lassen, 2000), which may indicate a less important role for insolation but might also indicate a lag time in important feedback mechanisms or the effect of oceanic cycles. Scafetta and West (2006, 2009) state that solar irradiance still accounts for 25 to 35% of the warming between 1980 and 2000 using the better Active Cavity Radiation Irradiance Monitor (ACRIM) composite total solar irradiance. Only in recent years have satellites been launched that are capable of measuring the slight variations in solar irradiance (Baliunas, 2005), and the record is too short for sweeping conclusions and certainly too limited to deny the role of solar irradiance variations. "Viewing the sun as redolent with coruscations in magnetic winds, particles and electromagnetic radiation billowing on scales of seconds to millennia and accompanied by changing fluxes of cosmic rays traveling near the speed of light that produce nothing more adverse than quaint auroral displays and cosmogenic isotope blips in records from environmental repositories seems an absurd assumption to hold while facing observed past ecosystem change and their evident correlations with solar variations"(Baliunas, 2005, p. 232). More recent research appears to strengthen the position that variations in solar irradiance are one of the most important forcing mechanisms (Brugnara et al., 2013).

Table III. Periods of unusually low sunspot activity during the Little Ice Age.

Periods of Low Sunspot Activity	
Years	**Designation**
1040–1080	Oort Minimum
1280–1350	Wolf Minimum
1460–1550	Spörer Minimum
1645–1710	Maunder Minimum
1790–1820	Dalton Minimum

Greenhouse Gases

Water vapor, methane (CH_4), carbon dioxide (CO_2), and oxides of nitrogen are "greenhouse gases," i.e., gases that tend to trap infrared radiation (heat) in the atmosphere and produce a warming effect. Their effectiveness is from greatest to least in the order listed above (Oard, 2006), but CO_2 is the gas that receives greatest attention in the press. Water vapor contributes approximately 95 percent of the 36°C (65°F) greenhouse warming effect that keeps us all from freezing to death; CO_2 contributes only a minor amount.

Mankind has little control over water vapor, while many agricultural and urban processes produce methane and carbon dioxide. Anthropogenic CO_2 is considerably larger than anthropogenic CH_4 but a tiny fraction of natural carbon reservoirs (Soon et al., 1999). Yet the effect of carbon dioxide has been greatly exaggerated in the current global climate-change scare, perhaps because climatologists routinely simulate the temperature rise with a *doubling* of CO_2 and get anywhere from a 1½ to 6°C (3 to 11°F) warming. The range of variation is due to the many models used by various institutions and the degree of complexity of the models.

However, nature has run its own experiment with the rise of carbon dioxide and other greenhouse gasses (e.g., methane). Carbon dioxide concentration has risen 30–35% since the end of the Little Ice Age, and the other greenhouse gasses have increased another 30% in "carbon dioxide equivalency" units (Oard, 2006). So essentially CO_2 has risen 60–65% while the global temperature increase has only been about 0.7°C (1.2°F)—assuming these temperature records are correct, which they probably are not (Balling, 2005). Since no one knows how much of this temperature increase was natural—and we know that a significant part of it was natural—we will assume half of the CO_2 is anthropogenic, from burning fossil fuels. This then means that the entire human contribution to carbon dioxide since the Little Ice Age has resulted in a temperature rise of 0.35°C (0.6°F), showing the prevailing computer models are all far too sensitive to carbon dioxide. (At this rate, a doubling of CO_2 would cause only about a 0.5°C (1.0°F) increase in global temperature, which makes even the model that produces the least temperature rise three times too high!) The coauthor has worked with such models for thirty years and understands their limitations; the models have a difficult time grasping such variables as solar and infrared radiation processes, cloud processes, ocean-atmosphere feedback processes, and the changing reflectivity of snow and ice cover under various atmospheric conditions.

The atmosphere is not nearly sensitive enough to carbon dioxide for the observed changes to have had much influence on twentieth-century global warming, the Little Ice Age, or the Medieval Warm Period. Besides, there was likely little change in carbon dioxide during the Little Ice Age. The increase in CO_2 has largely occurred since the Little Ice Age ended (Figure 3), and some believe it is what has saved us from the grip of this ice age (Grove, 1988)! Much of the observed increase may simply be the natural exsolution of carbon dioxide from the oceans and other natural reservoirs (Elberling, 2005; Jones et al., 2000), with the fossil fuel contribution being likely far less than the 50% we assumed above (Soon et al., 1999). Carbon dioxide concentration tends to lag temperature, not lead it, which discounts the role of CO_2 as the driving force of the temperature increase (Posmentier and Soon, 2005). In addition, up to a third of the above temperature increase may be an artifact of the measurement techniques (Balling, 2005). "The result that emerges is that current climate model estimates of global temperature changes owing to increased atmospheric CO_2 concentration remain highly uncertain" (Soon et al., 1999, p. 159).

Table IV. Summary of major climatic-forcing mechanisms.

Climatic-Forcing Mechanisms	
Mechanism	Effect
Insolation	Direct proportion
Volcanism	Inverse
Greenhouse gases	Direct proportion
Ozone	Direct effect on stratosphere
Cosmic rays	Uncertain (probably direct)

Milankovitch Mechanism

While the Milankovitch Mechanism (changes in insolation caused by slight differences in distance from the sun and tilt angle) is the undying favorite of uniformitarian explanations for ancient ice ages, the large timescale over which it would apply renders it completely powerless to explain the Little Ice Age (Grove, 1988; Guiot et al., 2005; Mann, 2002). It is also inadequate to explain any previous ice age (Oard, 1984a, 1984b, 1985). Even in light of the inadequacy of the Milankovitch Mechanism to explain a small fraction of Little Ice Age forcing, it receives its due homage in such discussions (Schwarzschild, 2012), probably because there is nothing else within grasp for those who cling to traditional old-earth thinking.

Feedback Mechanisms

There are two types of feedback mechanisms: positive and negative. Positive feedback mechanisms serve to strengthen the causal signal, while negative feedback mechanisms tend to put the brakes on the change in climate and hold it closer to equilibrium. Important mechanisms are listed in Table V.

Ice and Snow

Ice and snow form an obvious positive feedback mechanism for cooling. Their reflectance (albedo) serves to return some of the sun's energy to space that would otherwise warm Earth. The result is lower land, sea surface, and air temperatures, so more of the precipitation that falls will fall as snow. Lower temperatures result in reduced melting, and glaciers tend to grow. Thus, growing glaciers tend to promote glacial growth, and shrinking glaciers tend to accelerate their own demise.

Miller et al. (2012) suggest ice cover may hold the key to explaining the Little Ice Age. They combine radiocarbon dating of recently exposed moss from Baffin Island ice caps, varves in Iceland, Icelandic foraminifera in sediment cores, and volcanic aerosols from ice cores in Greenland to infer that major volcanic eruptions triggered growth of sea ice that then produced the century-scale changes of the Little Ice Age. Coordinating these disparate data can be problematic to say the least (Eiríksson et al., 2000; Oard, 2005), but the feedbacks involving sea ice and snow cover are doubtless important (Bengtsson et al., 2004).

Clouds

The feedback effect from cloud cover is not so clear. Nocturnal cloud cover reduces heat loss to space, but cloud cover during the day reflects considerable solar radiation and absorbs some of the rest so that less reaches the ground. The altitude of clouds also has a bearing on how they affect surface air temperatures.

Table V. Summary of major climatic feedback mechanisms.

Climatic Feedback Mechanisms		
Mechanism	**Feedback**	**Effect**
Snow albedo	Positive	High albedo reflects radiation, low albedo absorbs radiation.
Greenhouse gases	Positive	Warming from GHGs results in exsolution of CO2 and more water vapor production; decrease in GHGs results in more absorption of CO2 and less production of water vapor.
Sea ice cover	Positive	Sea ice cover affects albedo over ocean, as well as winds, currents, and water vapor production. More ice reduces marine moderating influence but may also reduce snowfall.
Vegetation	Positive or Mixed	Vegetation moderates climate. More vegetation decreases albedo and warms cold regions.
Cloud cover	Negative or Mixed	Increased water vapor production increases cloudiness. Reduced solar radiation by day, but less nocturnal radiative cooling. Water vapor is also the most effective greenhouse gas. Rising temperatures increase cloud cover.
CFCs and decreased ozone in stratosphere	Positive or Mixed	Increased CFCs decrease ozone, which results in increased radiation to surface. CFCs and ozone are greenhouse gases.
Stratospheric Temperature	Positive	Decreasing stratospheric temperature with decreasing ozone results in greater ozone destruction and more stratospheric cooling (effect on troposphere is uncertain).

Vegetation and Land Use

Vegetation and land use can greatly impact surface air temperatures. This is clearly illustrated by the "urban heat island effect" or by its opposite—the moderating effect of an "urban forest." On a regional scale, widespread deforestation can result in more extreme climate, and the drier air resulting from desertification can act as a positive feedback mechanism to produce drier conditions with greater temperature extremes. As mentioned in Part III of this series (Klevberg and Oard, 2012a), loss of woodland and soil in Iceland likely worsened climatic deterioration there.

Ozone

Ozone is a greenhouse gas, and ozone depletion produces a cooling effect (Balling, 2005), at least of the stratosphere. Stratospheric cooling has been observed concurrently with land surface air temperature increases. More cosmic radiation would be expected to reach the earth's surface with less ozone to intercept it. How the troposphere and stratosphere interact is incompletely known.

Chlorofluorocarbons

Chlorofluorocarbons (CFCs) are present in the atmosphere only at very low concentrations and may not have a significant direct impact on climate; however, they are known to be very effective greenhouse gases on a per-mole basis and should not be discounted. More importantly, they may have a profound impact on ozone, which is the reason for their being banned under the Montreal Protocol (Lu, 2013). This is particularly true in the polar regions, where ice crystals in stratospheric clouds facilitate ozone destruction at rates several orders of magnitude higher than in lower latitudes where these ice crystal substrates are lacking (Lu, 2013). Ozone is thought to dampen solar forcing (Shindell et al., 2001), so a reduction in ozone would make solar forcing more effective.

Other Feedback Mechanisms

Other feedback mechanisms, some poorly understood, include sulfate aerosols, ocean currents, and atmospheric dust. Volcanic aerosols can interact with ozone in the manner of CFCs, with complex results due to the uneven effects between the polar and tropic regions and between the stratosphere and troposphere (Robock, 2000). Svensmark (2007) proposed a link between galactic cosmic ray intensity and cloud cover, but this has been widely disputed (Hebert, 2013; Lant, 2003; Sloan and Wolfendale, 2008). Nonetheless, regardless of whether Svensmark and others have overstepped their data, cooling of the lower troposphere, minimum solar irradiance, and maximum cosmic ray incidence (extraterrestrial ions) do coincide (Baliunas, 2005). Sulfate aerosols from volcanic eruptions are not as obvious as volcanic ash but may be more important in inducing cooling (Ward, 2009). Several other possible feedback mechanisms have been proffered (Yndestad, 2006).

Is the Earth Warming?

A disturbing trend is the tendency for questions such as "Do you believe in global warming?" or "Do you recognize the fact of climate change?" to be posed without the scientific mooring necessary for meaningful discussion. It becomes a political litmus test rather than a genuine effort at understanding nature. Is Earth warming? Compared to what?

The Earth Has Been Warmer Than at Present

While some in the popular press are careful to talk about "climate change" rather than "global warming," the overall dominance of one particular view on a scientific question is amazing. The word "consensus" comes up repeatedly, as if the scientific method were somehow democratic. An article entitled "The Truth About Denial" in *Newsweek* magazine asserted, under the heading "consensus," "Current warming is 10 times greater than ever before seen in the geologic record. The chance that the warming is natural is less than 10 percent" (Conant et al., 2007). While popular media make such brash statements, few practicing scientists believe this hype (McKitrick, 2005). Virtually no geologist, evolutionist or creationist, would accept the *Newsweek* statement.

Warmer periods than the present in ancient times (by evolutionist definition) are widely accepted (Balling, 2005; Lillehammer, 1994; Follestad and Fredin, 2007; MacDonald et al., 2000; Posmentier and Soon, 2005; Tarasov et al., 1999; and virtually any historical geology textbook). Iceland experienced warmer conditions in recent millennia per evolutionist dating (Björnsson, 1980; Caseldine and Stötter, 1993; Wastl et al., 2000). Plant remains have been uncovered well above treeline on the Hardangervidda in Norway that appear "fresh" yet are far higher than their present range (Grove, 2001). Pine stumps indicate that the treeline here was much higher in the past than it is today (Lillehammer, 1994). Evidence from northern Norway suggests the Medieval Warm Period was more significant and the modern (post-Little Ice Age) warming less than IPCC pundits proffer (Bakke et al., 2005). Still warmer conditions apparently existed farther back in time (Bjune et al., 2005) and in many parts of the world outside the study area (Pellatt et al., 2000; any historical geology textbook).

The Earth Has Been Colder Than at Present

In light of the evidence provided in this series, little need be added than the fact that global average temperatures have been significantly lower (i.e., a few degrees Celsius) in the past. Excellent documentation of this in regions other than our study area can be found especially in Grove (1988) but also in many other sources (e.g., Björnsson, 1980; Follestad and Fredin, 2007). Some well-attested modern climate models for the past millenium also indicate significant Little Ice Age cooling (Briffa and Osborn, 2002; Guiot et al., 2005; Figure 1). Traditional ice age theories hold to considerably colder conditions in the past.

Scientific Approach

To approach the question of whether measurable climatic warming is occurring globally requires not only adequate spatial and temporal data collection, but also a datum against which to compare the climatic data. Global warming (or cooling) relative to what?

We also need to be clear which data set is being examined. Most of the data considered of late have been surface air temperatures, while temperatures in the troposphere have warmed significantly less than claimed on the surface (Christy, 2005). The tropospheric temperatures are probably more important for effective climate modeling.

Humility is essential to good science, even though social pressures may exist for scientists to overstep the justified inferences from their data. "In fact, people have little understanding of the exact nature and causes of climate change, in spite of—or perhaps because of—the vast amount of sensational literature available" (O'Keefe and Kueter, 2005, p. vii). "Our greatest problem is not ignorance; it is the presumption of knowledge" (O'Keefe and Kueter, 2005, p. viii).

A related question that seems to be ignored or stifled is whether global warming would be a bad thing. Climates have changed in the past, and the effects of those changes may be complex. In at least some instances, positive changes may result from increases in average temperature (McCarl, 2010) or atmospheric carbon dioxide concentration (Robinson et al., 2007).

The Earth Will Be Hotter Than at Present

Whether one believes in "global warming" now, real global warming is coming. Hegerl et al. (2006) consider the IPCC published climate sensitivity of 1.5–4.5 K (about 3 to 8 °F) to represent the maximum, but this assumes uniform conditions. Unusual conditions are indicated in Revelation 16:8–9. This insight is not dependent on our knowledge or perception but has been provided to us by the One who has been present and in control of our planet's climates throughout its history (Psalm 147:7–8). We can be confident of its fulfillment in the near or distant future.

Speculations on Climate Forcing

The effects of the Little Ice Age were significant. For instance, glaciers advanced all over the world, temperatures were significantly cooler, and the equilibrium line altitude was about 150 m lower than at present (Klevberg and Oard, 2012b). Before that, the Medieval Warm Period was just as dramatic on the warmer side.

As can be seen from Figure 5, both solar variations and volcanism seem to have some connection with temperature fluctuations of the past millennium but no completely clear correlation. The clearest appears to be what was likely the coldest period of the Little Ice Age, which began with significant volcanism closely followed by the Maunder Minimum. Neither forcing mechanism appears adequate, nor do greenhouse gas concentrations explain climatic history. "However, the natural radiative forcings are either weak or, in the case of explosive volcanism, short-lived … thus requiring substantial internal feedback. The LIA [Little Ice Age] is particularly enigmatic. Despite extensive historical documentation and a wide array of proxy records that define climate change during the past millennium … there is no clear consensus on the timing, duration, or controlling mechanisms of the LIA" (Miller et al., 2012, p.1).

Miller et al. (2012) are right to acknowledge the importance of feedback mechanisms. While quite possibly flawed (cf. Vinje, 2001), their sea-ice feedback model does show promise for explaining much of the climate change in our study area. Yet it still does not explain climate change elsewhere. Regional causes cannot explain the Little Ice Age. "Glaciers on every continent have expanded in the last few centuries; the Little Ice Age was a global phenomenon" (Grove, 1988, p. 354).

"Many workers have concentrated their attention on one possible cause, more or less ignoring the rest, whereas it is very likely that several factors are involved. Explanations advanced fall into two main classes, those which rely on internal adjustments within the atmosphere-ocean system and those invoking external factors to account for changes in the mean temperature of the globe"(Grove, 1988, p. 359). This is correct. While we believe variations in solar irradiance were the primary driving force for the Little Ice Age, we do not discount the role played by volcanism and various feedback mechanisms (including CO_2 and CFCs), particularly on the decadal to century scale (cf. Bertrand et al., 1999; Lu, 2013).

Such climatic changes as the Medieval Warm Period and Little Ice Age have virtually nothing to do with the amount of carbon dioxide. In fact, from proxy studies, atmospheric carbon dioxide concentration changed little during those periods. Such marked natural fluctuations in climate are telling us that the current global warming of up to 0.7°C (1.2°F) is at least partly natural, especially in view of the high number of sunspots and low amount of volcanic effluents in the stratosphere for the twentieth and early twenty-first centuries.

The debate today rages (when not stifled!) over the percentage of greenhouse warming that is natural and the percentage that is man-made. Every extreme is represented in the marketplace of ideas. We know from our study of the Little Ice Age that the IPCC, most of the media, Al Gore (2006), and other alarmists who say that man is nearly 100% responsible, are exaggerating (Horner, 2007; Lomborg, 2007). Furthermore, they are being unscholarly, since most refuse to consider natural fluctuations or the role of CFCs. They can cause great harm if they manage to get all they want politically and economically. The motivation here cannot be an honest search for the truth!

Summary

To what heights (or depths) would current climate modeling have ventured without the constraining influence of historical records and the Little Ice Age? These constraints should remind us that humility is a prerequisite for good science. If we are to effectively "think God's thoughts after Him," we must approach the study of nature with humility and wonder. Our knowledge of climatology is rudimentary at best, and in relation to the past, science cannot discover truth but serves simply to temper historical speculation.

Yet progress has been made. Based on what has been shown in this series thus far, we present the following conclusions:

- The Milankovitch Mechanism has no explanatory power for the observed Little Ice Age and probably none for previous glaciation(s).
- Changes in solar irradiance have had an important and global effect on climates but cannot be the sole source of the Little Ice Age.
- Volcanism has had an important role in climate change, especially in triggering cooling. However, its role is regional and short-lived, and therefore inadequate to explain the Little Ice Age.
- Feedback mechanisms appear to be very important but poorly understood. Such mechanisms include ice and snow cover on land and sea, cloud cover, land use, weather feedback patterns (e.g., NAO, ENSO), and possibly ocean current changes, greenhouse gasses, chlorofluorocarbons, and cosmic rays.

Since any speculative ice age would be similar in kind to the Little Ice Age and differ from it only in magnitude, the same causal relations would apply. The Little Ice Age as an analog for a Great Ice Age (or ice ages) in the past will be addressed in Part VII of this series.

Historical records set the Little Ice Age apart from times of glacial advance that preceded it. There is no substitute for eyewitness accounts. For that reason, members of the Creation Research Society place their confidence in the God who was present and active at the creation of the universe rather than the unconstrained speculations of those who were not. In regard to climate change, this not only gives us confidence that the climatic system is likely to be more complex and resilient than fearmongers allow, but we also acknowledge that our moral actions may affect climate far beyond the scale of the "urban heat island effect" or even global warming (Revelation 16). This calamity we will not avert by merely reducing our "carbon footprint"!

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Glossary

tropopause: the layer in the atmosphere just above the troposphere in which the temperature changes from decreasing with height to increasing with height.

troposphere: the lower portion of the atmosphere, where common weather phenomena occur. It extends from ground level to the tropopause.

mesosphere: the layer of the atmosphere above the stratosphere in which the temperature decreases with height again.

stratosphere: the layer of the atmosphere above the tropopause and below the mesosphere. This is where cosmic radiation reacts with O_2 to form O_3, thus shielding the earth's surface from much of the cosmic radiation.

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Appendix: Political Influence and Junk Science

Junk science and pseudoscience often result from political influence in the awarding of research grants, teaching appointments, etc. (Bergman, 2008). This is also true in the study of climate change, a clear example of the reinforcement syndrome (Oard, 1997). This produces the "consensus." Many have documented the limitations of peer review in science in general, including the use of peer review as a tool to censor creationists (Anderson, 2002, 2006a, 2006b, 2008; Lumsden, 1992) and skeptics of big bang or "standard model" cosmogony (Arp, 1998). The use of peer review by *Nature* and other well-known journals to censor global warming skeptics also has been documented (McKitrick, 2005).

We have heard some informal opinions against Lu's recent work (2013), which is not surprising since he predicts the long-term result of the Montreal Protocol will be the end of global warming. This undermines the IPCC position that carbon dioxide is the culprit and must be controlled at all costs. One frequent criticism of Lu and global warming skeptics seems to be that correlation does not establish causality. This is true and is a good example of the pot calling the kettle black.

Letters to the Editor

The policy of the editorial staff of CRSQ *is to allow letters to the editor to express a variety of views. As such, the content of all letters is solely the opinion of the author, and does not necessarily reflect the opinion of the* CRSQ *editorial staff or the Creation Research Society.*

The GGU-Model and Psalm 148:6

Wayne Spencer in his letter, "The Fate of the Universe and Psalm 148" (Spencer, 2014), gives an interpretation for the phrase "ever and ever" and the word "never" in the NIV version of Psalm 148:6: "He set them in place for ever and ever; he gave a decree that will never pass away." The KJV also uses the phrase "for ever and ever," but does this phrase carry the same meaning we assign to it?

The general grand unification model (GGU-model) is based not upon our intuitive comprehension of "time" but rather upon the nontemporal ("atemporal") concept as expressed via the "sequence" notion (Herrmann, 2013a). One of the important "intuitive" definitions for the sequence notion is "the coming of one thing after another." But, what does the phrase "after another" signify? It is not well known, but the foundations of mathematics are based upon human intuition and physical experiences. A major example of this is "matrix theory." A matrix is defined geometrically and visually as a rectangular array of entities.

The matrix basic construction is relative to the human concept of a visual geometric array as customarily displayed and a "left-to-right" ordering relative to our left and right hands. The idea of objects being "above and below" is also a necessary concept that employs our physical experiences. If these intuitive ideas were not the case, then matrix theory probably would not have been developed.

A sequence is based upon a perceptive process that we first learn as children. This is the process of "counting" and, for us, counting is displayed in an ordered left-to-right-hand manner. We learn that when we count, we have "one," then this is "followed by two," and then this is "followed by three," etc. In mathematics, this intuitive notion is continued when one writes {1,2,3,4}. This symbolism represents a "finite" sequence. In this case, the symbols "{" and "}" do not mean that this is to be considered a truly formal "set" since such representation for formal sets does not include the intuitive "order" concept being displayed by the sequence notation. In the mathematics literature, when such a string of symbols is used to represent a sequence, I have never seen it written as {2,1,4,3}. If this were only to be considered as a formal set, then {1,2,3,4} = {2,1,4,3}.

The phrase translated "for ever and ever" comes from the Hebrew *'ôwlâm* along with *'ad*. It is the same construction as in 1 Chronicles 16:36. The term "eternal" is also used. But, "In fact, the 'eternal' and 'for thousands of generations' stand in parallel in v. 15" (Guhrt, 1971, p. 828). In the LXX, the Greek *aiōn* is used for it. It appears that, for the ancient Hebrews, "for ever and ever" is better understood as "from generation to generation," where "generation" mostly refers to a finite sequence of human being physical events (Guhrt, 1981, p. 828).

A "generation" is often associated with a time measurement. However, such a time measurement is produced by a finite sequence of physical events $\{a_1,a_2,a_3,\ldots a_n\}$, where n is the number of events that comprise a generation. It is the counting notion relative to the displayed numbers 1,2,3,4,…n that implies the intuitive ordering of the events. The n indicates a general counting number greater than 4. Then this corresponds to a time measurement. Considering Isaiah 66:23 (700 BC), the GGU-model rationally yields the "for ever and ever" as a finite sequence of finite sequences of physical events. Symbolically, this can be expressed as $\{a_1,a_2,a_3,\ldots a_n\},\ldots \{a_{i+1},a_{i+2},a_{i+3},\ldots a_m\}$, where $i \geq n$. Beyond the last physical event a_m, from the viewpoint of our "well-ordered" counting number perspective, there is a sequentially infinite physical-like existence. Only God knows the value of the "last" m that occurs just prior to the sudden appearance of the new heavens and earth.

Such collections also include those designed to satisfy the participator requirements. That is, by our allowed choices, comparatively different "slices" taken from various designed universes are physically realized. Thus, as our universe develops physically, the set of participator designs (a "mental" decree) is not alterable by the actions of the participator. Each member of the collection is fixed. Relative to the ancient Hebrew concept for the physical development of our universe, this satisfies the "never pass away" notion. Spencer notes this fact about the earth.

It is difficult to escape from the requirement that originally the earth, its local environment, and the universe were created as entities, where measurable physical time has no meaning relative to death; that is, relative to the finite time span we today associate with physical death. Thus, as in the Spencer letter, it is God's design that determines whether this collection is itself finite. As of 700 BC, the ancient Hebrews' mindset appears to have been that "ever and ever" signifies a finite collection of finite generations with the last *m* humanly unknown.

I note that in Greek literature the idea of an immeasurable type of super-time did not appear until the time of Plato (400 BC). This super-time notion seems to correspond to our notion of a "completed infinite." In the late 1800s, certain mathematicians rejected such a notion since they claimed we could not "imagine" it. As shown in Herrmann (2013b), this claim is false.

Consider next Psalm 119:90: "You established the earth and it endures." This is fact from both the design and the production viewpoint. From the design viewpoint, the construction of the developmental paradigm portion of the GGU-model states that God's designs cannot be altered. This implies that no created entity can alter these designs. No created entity can alter the physical behavior they depict. Then there is Jeremiah 33:25: "I have … established my covenant with day and night and the fixed laws of heaven and earth." His covenant is the set of GGU-model fixed designs. His method of creation is fixed.

As a universe progresses, the GGU-model predicts that the regulations we comprehend and that are satisfied by its step-by-step development cannot be altered. For the additional statement relative to the earth, "it cannot be moved" in Psalm 93:1, Strong (#4131) suggests that the verb translated "be moved" also carries the meaning "be removed" (Strong, 1890). The GGU-model participator aspect satisfies Spencer's remark that no created entity can alter these designs; that is, as here implied, no such entity can move or remove the earth.

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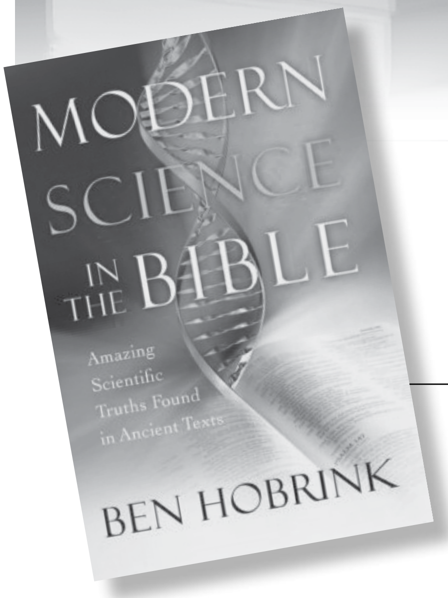
Media Reviews



Modern Science in the Bible: Amazing Scientific Truths Found in Ancient Texts

by Ben Hobrink

Howard Books, Brentwood, TN, 2011, 280 pages, $24.00

This book is divided into four sections. The first deals with epidemics, hygiene, and nutrition as presented in the Bible, especially in the Pentateuch (mostly Leviticus). This part presents the various laws and regulations the ancient Israelites were commanded to adhere to for a healthier life, even as they were surrounded by pagan cultures whose treatment of these issues were very unhealthy and unsanitary. The commands are presented that forbid the eating of certain animals, like pigs, which were filled with numerous diseases and parasites. Also included are matters of good personal hygiene and the importance of circumcision.

The second section discusses the "natural science" that interfaces with Noah's ark, the global Flood, meteorological topics found in Scripture, the "flat-earth myth," astronomy, probability, and the veracity of biblical prophecy.

The third section addresses the creation-versus-evolution debate. This includes aspects of biology such as intelligent design, transitional forms, irreducible complexity, geology, the evolutionary timescale versus the fossil record, and thermodynamics. A subsection presents evidence for a young earth.

The fourth section delivers a good exposition on the reliability of Scripture, which delves into the various arguments for the authority and inspiration of the Bible. This section deals with supposed mistakes or errors in Scripture and the importance of textual criticism. It briefly discusses how archaeology confirms the Bible, especially the books of Moses.

There is a final short chapter that examines miscellaneous issues from a biblical perspective, including agriculture and social laws. There is also a testimonial from the author, who came from a Christian home but in later life engaged in Eastern religions and finally came back to an authentic encounter with God and Christian faith through the Open Doors ministry.

The book is well written and easy to understand, with a layman readership in mind. Hobrink leans heavily on research and prior writings of other creationist authors and researchers. This book's audience is Christians who desire a readable and brief treatment of various issues hinging on the nexus of Scripture and contemporary science. This hardcover book has a recommended resource section, 16 pages of endnotes, and an index. The volume was originally written in Dutch and printed in the Netherlands in 2005 and later translated and published in the United States.

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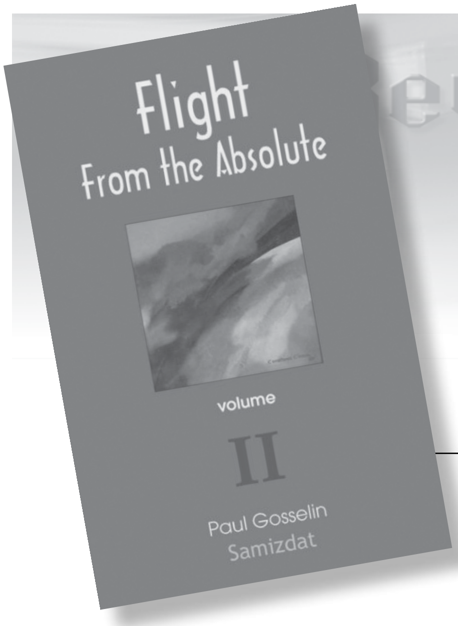
Reviews



Flight from the Absolute, Vol. II

by Paul Gosselin

Samizdat, Quebec, Canada, 2013, 563 pages, $28.57

Author Paul Gosselin has obviously invested much time in producing volume II of a series centered on social anthropology as the umbrella topic. Volume I, while setting a platform for volume II, need not be read before this edition. The merits of volume II include thorough definitions for science, religion, cosmology, the enlightenment, myth, modernism, and postmodernism. These subjects are discussed in the context of "absolutes." Gosselin provides a very thorough bibliography, notes, descriptions of the major origin narratives (or myths), and a full chapter on his conclusions. There is also a chapter on "What is a Creationist?"

The book starts by pointing out that most religions come with presuppositions that are included as part of a cosmology. Cosmology nearly always is accompanied by an origins myth. Evolution, with its complex origins myth, has replaced the biblical account of the Creation in most of the Western world. The interaction of the scientifically generated enlightenment with modernism and postmodernism in terms of logic and philosophy is the bulk of the book's discussion. Postmodernists have rejected absolute truth, and therefore science as absolute truth. However, postmodernists seem ambivalent about evolution, treating it as fact. While some postmodernists are critical of evolution, they are scarcely allies of those promoting intelligent design and creation. Postmodernists are captivated by the desire for self-fulfillment without moral absolutes. Gosselin states, *"There is little reason to believe that postmoderns could truly break with many of the basic attitudes of modern ideologies … due to the fact that their identity nevertheless remains rooted in the same cosmology"* (p. 370). Evolution, with its origins myth, serves postmodernism well.

Gosselin lives in Quebec, where the French culture and education is much the same as that of France. Many French are convinced of the axiom that evolution equals science, and no one dares oppose this doctrine for fear of being "excommunicated" from the intelligentsia. Gosselin spends several chapters on the saga of Austrian-born Karl Popper (1902–1994), who early in his career as a philosopher of science stated some doubt about Darwinism and neo-Darwinism. The high priests of evolutionism responded with uniform condemnation of Popper, and he did some backtracking for the remainder of his life. He ended conflict with the intelligentsia of Europe by "believing in" evolution.

Gosselin covers the writings of prominent scientists, historians, philosophers, and theologians. A bibliography of the modern creationist movement starts with Douglas Dewar in 1931 and ends with Steven Boyd in 2013. Likewise, the intelligent design movement is traced, followed by "independent" critics of evolution. Readers will gain insight into the predominant thinking and beliefs of the academic and intellectual elite of the Western world. Young-earth creationists will need to think through which opponents of scientism and evolution would help their cause.

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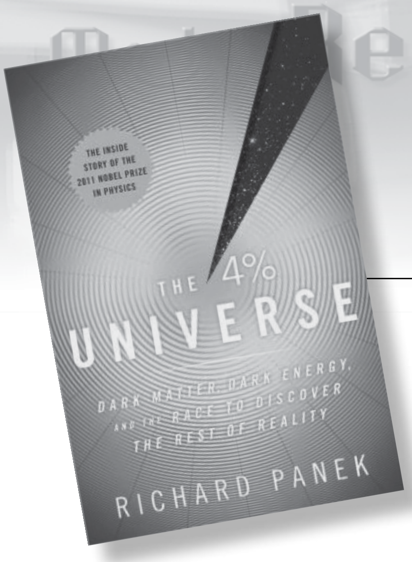

The 4% Universe

by Richard Panek

Mariner Books, New York, 2011, 297 pages, $6.38

Richard Panek is a nonfiction writer who received a New York Foundation for the Arts Fellowship to help him write this behind-the-scenes story of major discoveries that formed modern cosmology. As stated in Panek's biography, "He has no background in science, but he hopes that by combining the exploratory sensibility of journalism with the storytelling techniques of long-form narrative, he can illuminate and humanize science for readers" about these popular science topics. The main topics addressed in this book are contained in the subtitle *Dark Matter, Dark Energy, and the Race to Discover the Rest of Reality*.

The book is well organized, with a table of contents, acknowledgments, prologue, twelve chapters, epilogue, brief notes, works cited, and a general index. In the prologue, Panek writes about the possible detection of dark matter (DM) in an iron mine in Minnesota during 2009. There were only two possible detections, so statistically the data does not prove that DM exists, much less what it is. Panek goes on to discuss the current secular view of the universe. Astronomers claim that only 4% of the matter in the universe is ordinary atomic matter, 23% is dark matter, and 73% is dark energy. Dark energy (DE) is an entirely unknown substance.

Part I, chapters 1–3, recounts the initial measurement of cosmic microwave background radiation (CMBR) by Penzias and Wilson in 1965. The temperature of the CMBR was tied theoretically to the big bang (BB) cosmology model as it had been predicted earlier by theorists. During the same time frame, the discovery was made that all the stars in the outer Milky Way (MW) galaxy have nearly the same linear tangential velocity. Apparently their velocity does not depend on their distance from the galaxy center, in contrast to the velocity of planets around the sun. This characteristic of a spiral galaxy has now been measured in many nearby spiral galaxies, and it has been given the name "a flat rotation curve." This effect has been theoretically tied to halos of DM around galaxies in the BB model.

In Part II, chapters 4–6, Panek chronicles the history of the use of supernovae as a standard candle for distance measurement. The first group to promote this method was led by Saul Perlmutter at Lawrence Berkeley Laboratory. The emphasis was on relatively nearby supernova since those were the only ones that could be detected and measured in the late 1980s. By 1994 only one supernova at cosmic significant distance had been discovered. A second group headed by Brian Schmidt decided that an automated method to find longer distance supernovae of specifically Type 1a was required. By mid 1995 this team detected the farthest Type 1a supernova yet recorded. Even with a six-year head start and a more numerous database, the Perlmutter group was reluctant to announce that the expansion of the universe was accelerating instead of decelerating as they expected. Schmidt's group announced the acceleration first, based on their greater distance data. Members of both teams received recognition of the discovery because both had determined from independent data that there was not enough matter (both atomic and dark) to slow the expansion of the universe.

Part III, chapters 7–9, tells the story of how theorists came up with the explanations required to fit this new discovery into the BB model. First, an inflationary era had to be added to the BB model to overcome both the "flatness" and "horizon" problems. This era was added within the time before 10^{-35} seconds after the BB as an "ad hoc" assumption. But now the observation data from four separate groups of astronomers (two supernova, galaxy rotation, galaxy clusters) showed that the universe would continue to expand forever. On the theoretical side a new factor was needed in the equation of energy and matter in the universe. The Einstein "lambda" was reintroduced to enable setting the universe constant "omega" equal to one. However, this factor was now a variable and not the constant proposed by Einstein.

Part IV, chapters 10–12, discusses the search methods that have been used in an attempt to detect dark matter directly. Astronomers are confident that DM exists because observations of the effect of its gravity on atomic matter and electromagnetic radiation are consistent with the BB theory. Beyond detecting DM, they also developed new telescopes that are designed to detect the effects of DE. But these measurements are indirect, and they must be tied to their simulations also using the BB model. Any direct detection of DM or DE is still in the future.

The epilogue focuses on the problem of explaining the very existence of the universe. With 96 percent of the universe hidden in DM and DE, what scientists think they know about it could be in error. For example, they cannot explain the initial "quantum fluctuation." Could this be explained by God's creation of all matter and energy according to Genesis 1:1? The explanation of flat rotation curves for galaxies may not require the existence of DM. According to Scripture the stars were led out (Isa. 40:26), put in position (Gen. 1:17), and firmly established (Ps. 8:3) by God. Finally, DE is proposed to explain the expanding universe. But according to Scripture it is God who makes the expanse (Gen. 1:7) and stretches out the heavens (Job 9:8; Ps. 104:2; Isa. 40:22; 42:5; 44:24; 45:12; 51:13; Jer 10:12; 51:15; Zech 12:1). Could DM and DE just be manifestations of God's actions when He created the universe? In my opinion that is a more reasonable explanation of what mankind has discovered in the heavens.

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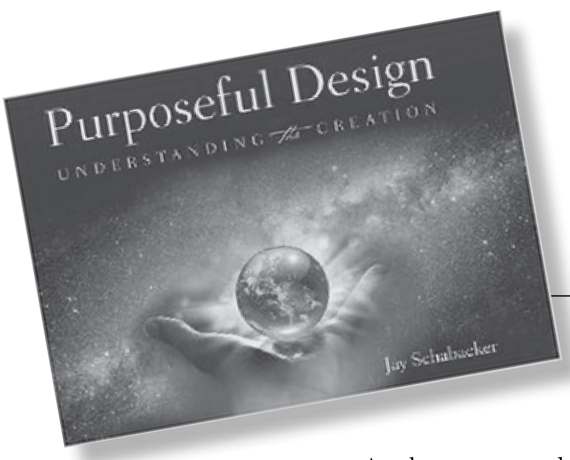

Purposeful Design

by Jay Schabacker

Self-published, 2013,
94 pages, $19.00

Author Jay Schabacker is a retired aerospace engineer, MBA investment advisor, and church leader. This writing comes from his passion for children's education, and the book has earned a homeschool book award. The title refers to examples of planned design found throughout nature. Beyond intelligent design, the book clearly points out the biblical Creator. A letter accompanying the book reads, "I wrote this book because I want everyone to have an immensely positive view of themselves … through understanding our own astounding and loving creation."

The book outlines the six supernatural days of creation with extra emphasis given to animal instinct, the human body, camels, seasons, and the tides. Quality color pictures accompany every page. Additional peer reviewing could have avoided some errors, including the following examples:

- "The moon doesn't rotate on its axis" (p. 8). It certainly does rotate in synchronism with its revolving, which is why we do not see the moon's "hidden" side.
- "The earth orbits the sun at a never changing speed" (p. 14). Orbital speed actually changes by 3–4% as the earth-sun distance varies during the year.
- The rain cycle (p. 18) is better called the water or hydrologic cycle.
- "This (moon) phase is known as the first quarter, because it occurs one quarter of the way through the month-long cycle" (p. 41). A better reason is that this particular phase shows one-quarter of the moon's total surface.
- "Astronomers recently discovered … the Whirlpool Galaxy" (p. 52). Charles Messier actually cataloged this particular galaxy in 1773, ten generations ago.

The book uses a large font, which is helpful to young readers; however, there is no index provided. The author's website is www.Jayschabacker.com.

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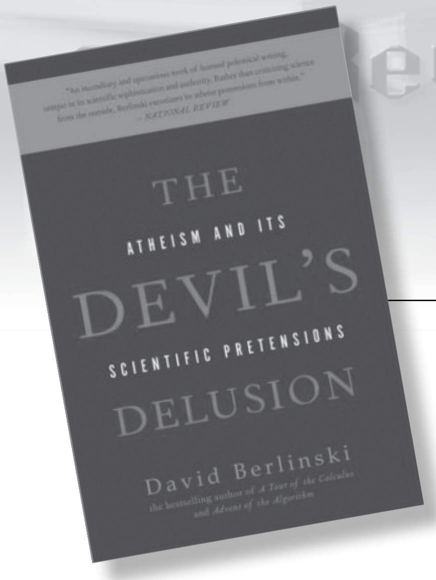

The Devil's Delusion: Atheism and Its Scientific Pretensions

by David Berlinski

Basic Books, Philadelphia, PA, 2009, 238 pages, $16.00

As the title implies, this 256-page book is technically a response to militant atheist authors, including Dawkins, Dennett, and Hitchens. But the book is a scientific *tour de force* in its own right. Though the preface paints the author out to be an agnostic, one wonders how sincere Berlinski is about this position. Perhaps as a secular Jew he finds it makes for better packaging and a more credible scientific stance in defending theism. But he never presents any real reasons for doubting God's existence in the book. The preface states, "Yet the book that follows is in some sense a defense of religious thought and sentiment. … A defense is needed because none has been forthcoming" (p. xiii).

David Berlinski is a healthy tonic to the hubris of the scientific elites who look down their priestly noses and preach to others as if they were without the foibles of prejudice or religious agendas. If a literate society like ours is still surviving 200 years from now, the militant atheists will be seen as a high point in the extravagant presumptions of scientism, and *The Devil's Delusion* will be a mitigating point in our favor as a reasonable society. The book is brilliantly written, if somewhat inaccessible. Berlinski's prose is a masterpiece of wit. But the average reader must first digest a couple of these chapters to really understand the metaphors being employed and where the trail of logic is aiming. Then they must go back and read the chapter a second time to ruminate on exactly what is being said. Nevertheless it is worth the effort.

The author is at his best when he is defending religion as no less reasonable a starting point than the presuppositions of naturalists. But he frequently gives over to clever rhetorical barbs. Chapter 9 ends thus: "When asked what he was in awe of, Christopher Hitchens responded that his definition of an educated person is that you have some idea how ignorant you are. This seems very much as if Hitchens were in awe of his own ignorance, in which case he has surely found an object worthy of his veneration" (p. 208). Berlinski also has a gift for dismantling a protracted, faulty line of logic with a simple question.

Berlinski succeeds in thoughtfully weaving a sizeable bit of Islamic tradition and Arab philosophy into the mix (pp. 13–17), as chapter 2 moves loosely through the moral argument in favor of religion. A tally of all the "excess deaths" due to wars and persecutions in our modern scientific era is meant to puncture the myth that our society has "evolved" past the days of barbaric, religiously motivated killing. The author clearly seems comfortable within Christianity, as he looks approvingly to Thomas Aquinas on multiple occasions. His grasp of biblical context is obvious from the carefully chosen verses occasionally inserted.

Chapters 5 and 6 build on the cosmological argument to show that a multiverse (or landscape) and the anthropic principle are no more reasonable a premise than Genesis 1:1. Using a multitude of pertinent quotes from leading scientists, Berlinski shows there is no reason to expect scientific laws and an ordered universe without a designer. After quoting from physicists who theorize that the entire universe came from absolutely nothing, an Islamic confession of God is followed by this: "So long as frank confessions are being undertaken, *I* must confess that a God looking agreeably like me makes precisely as much sense as an 'indeterminate sea of potentiality,' with the additional advantage that *He* is said to be responsive to prayer" (p. 97).

The book uses a full chapter to respond to the central premise of Richard Dawkins's *The God Delusion*: that an improbable God is less likely to be self-existing than an improbable universe. This chapter alone is worth the price of admission. It takes the refutation of the "Who made God?" argument to a whole new plane. For example, probability theory is brought to bear: "An improbable God must thus be improbable in virtue of the process that controls his probability. Just which random process is designed to yield the Deity as a possible outcome? It is by no means easy to say, which is a reason, I suppose, that on this subject, Dawkins says nothing at all."

Chapter 8 deals with the human mind, and the author clarifies, as he does on numerous occasions, the significant gap between elementary items that science studies and our complex human experience. For example, he punctures the reductionist concept of the "selfish gene" promulgated by Dawkins: "Richard Dawkins has gone out of his way to affirm that he, at least, is not under the control of his genes. … His genes are not so selfish as to tell him what to do" (pp. 176–177). I learned for the first time the extent to which Alfred Wallace came to doubt the provenance of the theory both he and Darwin formulated.

There are a few clear problems with the book. On page 55 the author slams the scientific method with no further explanation. This causes him to come off as a bit of a contrarian, rather than an even-handed referee of scientific pretensions. Chapter 9 is entitled "Miracles in our Time." The author equivocates a bit on *miracle* (playing on the wonder of human eyesight as if it were a miracle, for example). Finally, the book is difficult to follow at times. One sometimes wonders if a given statement is straightforward or really tongue-in-cheek sarcasm.

Since Berlinski approaches origins from an ID perspective, there are certainly some issues here for creationists. Chapter 4, "The Cause," celebrates modern big-bang theory as a tremendous accomplishment, incorporating it as a key part of the cosmological argument for God. On page 1 the author speaks admiringly of scientists who have accommodated religion, including Stephen Jay Gould, who famously proposed "Non-Overlapping Magisteria." But Berlinski is too exacting to espouse Gould's incoherent position, clearly affirming that science and religion cannot both be correct if their statements are at odds. But on pages 213–214 the point is made that the book of God's word and the book of God's work (nature) are not in conflict because they are the *same* book. Here creationists would disagree, distinguishing specific revelation from general revelation, and giving priority to the former.

The whole last chapter is given to a brilliantly conceived metaphor. After being presented with the affair of Galileo and the church (with some of the historical facts set straight), the reader is introduced to Cardinal Bellarmine, a man who tried to strike an accommodating tone with Galileo's work, suggesting that perhaps the Bible had been misunderstood to be geocentric. Then the whole scenario is exactly flipped: "If in the seventeenth century, the cardinal was willing to say that we might have misunderstood religion in order to uphold science, in the twenty-first, he is willing to say that we might have misunderstood science in order to uphold religion" (p. 218). In the modern analogue, the intolerant scientific elites become the inquisitors, the intelligent design crowd is Galileo, and David Berlinski humbly takes it upon himself to speak for the good cardinal. This book was reviewed previously in the *Quarterly* (DeYoung, 2012).

Reference

DeYoung, Don, Review of *The Devil's Delusion*, *Creation Research Society Quarterly* 48(4): 361.

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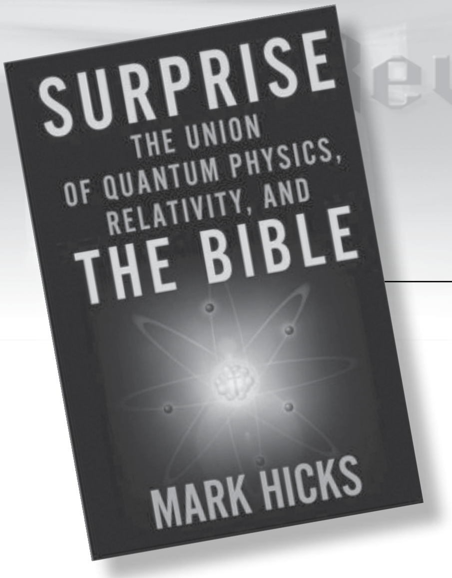

Surprise: The Union of Quantum Physics, Relativity, and the Bible

by Mark Hicks

WinePress Publishing, Enumclaw, WA, 2012, 194 pages, $13.57

Mark Hicks is a practicing attorney and graduate of Oral Roberts University. He also graduated from Regent University School of Law, where he worked with the American Center for Law and Justice. For a non-science major he does a remarkable job of describing the physical theories related to quantum mechanics, relativity, and electromagnetic radiation (light). He begins with what is known and unknown about these topics and then aims to prove they are connected when God is brought into the equation.

The book is well organized, with a table of contents, introduction, fifty-two short chapters, and endnotes. In the introduction, Hicks claims, "This is a book about perspective: the way both science and the Bible view the world and universe we call home." His perspectives on science as found throughout the book vary from theistic evolution to creation. He states that what scientists have documented in theory and experiments must be reproducible to be true. However, some of the expressed physical ideas are based on chemical element formation (nucleosynthesis) by supernovae extrapolated over evolutionary time, a model scientists cannot test. The author does state that the main problem with scientists who do not believe in God or the Bible is their skewed perspective. With such a perspective they often do not recognize the truth.

In chapters 1–13, Hicks recounts how the collective scientific knowledge about our universe was collected piece by piece, spanning history until the present. Before Einstein formalized general relativity, there were Newton's laws of gravity and motion. Before quantum mechanics was introduced by Planck, no one could explain how atoms are constructed or why they emit electromagnetic radiation. Chapters 14–19 describe the latest scientific perspectives on the universe and its formation. This starts with the big bang and how its results developed into the universe scientists observe today. The claim that there are only three fundamental forces dates the book's source material. More recent textbooks include a fourth force, the weak nuclear force that holds protons, neutrons, and other subatomic particles in place.

The main purpose for the book is uniting the Bible and modern scientific concepts, including quantum physics and relativity. Chapter 20 begins with a description of light as electromagnetic radiation that is dual in nature as both waves and particles. Hicks attempts to show that God is literally light, as stated in 1 John 1:1–5. The main point is that light has many of the same characteristics as God. Light, he says, holds all matter in the universe together (p. 73). Light is neither created nor destroyed but only transformed (p. 81). Light is the universal cause of all action in the universe (p. 85). Light conducts a universal symphony that keeps the physical universe in harmony (p. 89). Light speed is a universal constant (p. 108) and never varies. Light speed connects space and time, according to the theory of general relativity (p. 110). At the speed of light, time ceases to exist (p. 122).

Chapter 39 discusses variations of Young's experiment, in which light passing through two slits forms an interference pattern on a screen. When a detector is active at one of the slits, the result on the screen is changed to a random distribution of points of light. Switching the detector off causes the interference pattern to reappear. This is a mystery scientists have been unable to solve. A conscious decision by an observer switching the detector on or off changes the outcome of the experiment. The author implies that this experiment demonstrates that the whole world is subject to the conscious efforts of mankind. The remaining chapters bring into the discussion virtual particles, probability waves, and entanglement of particles.

The book does not make a clear distinction between physical and spiritual light. Both the Hebrew and Greek words for light have a spiritual meaning, which is metaphorical. The use of these words should be differentiated by the context in which they are found. For example, in Genesis 1:3 God commands physical light into existence. Since God already exists, this could not be referring to Himself as the physical light or its source. There are other references to physical light in relationship to God: He wraps Himself in it (Psalm 104:2), forms it (Isaiah 45:7), and dwells in it (1 Timothy 6:16). But God is a spirit (John 4:24) and therefore does not exist as physical light, even though he and his angels frequently appear surrounded by it.

God is the universal spiritual light, or illumination, of the world. God is light as protection from evil according to Psalm 27:1. In Proverbs 6:23 a parent's commands and teachings are described as light. The Messiah will appear as a great light in the land of Israel according to Isaiah 9:2. Believers in Jesus as the Savior are the light of the world according to Matthew 5:16. And Jesus is the light of the world according to John 8:12. In my opinion the distinction that exists between physical light and spiritual light is the difference between tangible and intangible. Spiritual light is not sensed by the eye or any physical detector but rather by the spirit or mind.

I would recommend this book for anyone interested in learning modern concepts about physical light and its relationship to the physical universe. Be warned, however, that this book includes a significant amount of scientific material that is dependent on evolution theories.

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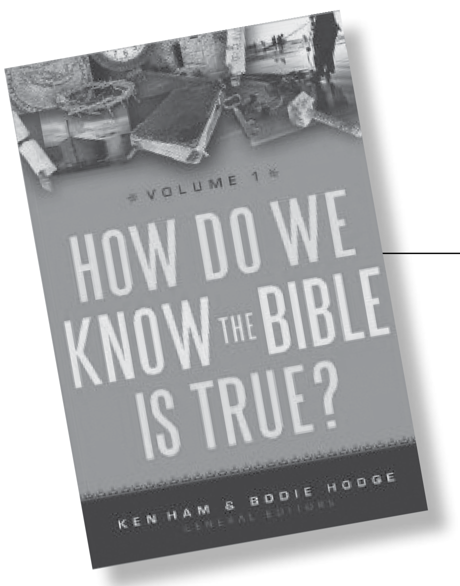

How Do We Know the Bible is True? Vol. 1

Ken Ham and Bodie Hodge, editors

Master Books, Green Forest, AR, 2011, 300 pages, $15.00

Many issues face the believer who accepts the history and science of the Bible. The issues go beyond young-earth creation and include the resurrection, miracles, and the authority of the Bible itself. This book focuses on questions pertaining to the reliability of the Bible, and many of them pertain to creation studies. A number of creation-science authors contributed chapters to the book. Chapters include "Is the Old Testament Reliable?" "Is Genesis a Derivation of Ancient Myths?" and "Did Moses Write Genesis?" The book defends the traditional, conservative position on the historicity of the Bible and its claims of authorship.

Not all of the included questions directly relate to creation studies, but all are interesting topics of importance to Christians who accept the claims of the Bible. Some of these questions concern broader apologetic and historical criticisms that have been levied against believers, including the resurrection, atheism, and the writings of other religions. There are many Scripture references, and potentially confusing issues are clearly and openly discussed. The contributors discuss various opinions within Christian circles when appropriate and present their own views with sensitivity.

There are 28 questions total. The book includes contributor biographies but no index. The chapters are short enough that a pattern of reading through one or two sections each day is an enjoyable way to experience the book.

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Ginkgo— The Tree That Time Forgot

by Peter Crane

Yale University Press, New Haven, CT, 2013, 384 pages, $40.00

Author Peter Crane has impressive credentials. During 1999–2006 he directed the Royal Botanical Gardens, Kew, UK. In 2009 he became dean of the School of Forestry and Environmental Studies, Yale University.

The book is an exhaustive study of the ginkgo tree and its influence in temperate climate locations around the world. This fascinating botanical component of creation is known as a classic living fossil. The title is a contradiction, or at least a glaring exception, to evolutionary change and eventual extinction. The book's inside cover describes the ginkgo as "the world's most distinctive tree … [which has] remained stubbornly unchanged for more than two hundred million years." The list of living fossils continues to grow, and an alphabetical list of examples is available (DeYoung, 2004, p. 21).

Inspiration for writing this book came from a historic ginkgo growing in England's Kew Gardens and dating from the 1760s. Chapter sections include gingko history, cultural connections, environmental threats, and practical uses for the tree. I am not a botanist and will leave the opportunity for a technical book review to others. Instead, to give the flavor of this important book, I will list several impressions and gleanings from the reading.

Spelling variation for the tree, ginkgo or gingko, is widespread. Naturalist Carl Linnaeus (1707–1778) is credited with coining the proper name, *Ginkgo biloba*, the latter term referring to the usual two-lobed leaf (p. 81).

The ginkgo is credited as perhaps the best known and most recognizable of 100,000 varieties of trees cataloged worldwide (p. xiii). Ginkgo fossils are found on every continent (p. 4).

The gender nature of the ginkgo receives full discussion, along with tips on identifying the sex of a particular tree (pp. 53–65).

Several evolutionary ancestors of the ginkgo are suggested. However, along with contemporary early plants with similar leaves, "the obvious fossil history of ginkgo peters out" (p. 91). There are at least two further problems for evolution models. First, "along with similarities [between plant fossils including ginkgos], there are many differences" (p. 96). Second, "In the fossil record … it is rare that anything approaching a complete plant is preserved" (p. 93).

The book gives exhaustive detail on ginkgo leaf and branch structure (pp. 35–41). Dedicated tree enthusiasts once counted every leaf on a slender fifty-foot maple, an eight-hour task with a final total of 99,284 leaves. A much larger, mature ginkgo is estimated to have several times this number, from 300,000 to 500,000 leaves (p. 32).

Traditional uses of the ginkgo, including from folklore, are many: pharmacy (fertility, at least forty flavonoids, freckle treatment, longevity, memory boost, various ailments and infections, pp. 242–249); food from the ginkgo nuts, in spite of their toxicity (pp. 226–233); and aesthetics (art, beauty, bonsai, wood carving, gardens, green space in cities, pp. 217–225, 234–241). Perhaps most familiar is the use of ginkgo extract for memory improvement, a controversial application. Clinical studies over the years have produced mixed results. The book quotes a 2003 *Scientific American* article conclusion on the topic: "This popular herbal supplement may slightly improve your memory, but you get the same effect by eating a candy bar" (p. 248).

Six ginkgo trees survived the 1945 atomic bomb explosion at Hiroshima. The trees were located just one mile from ground zero (p. 289). Under much milder stress, ginkgo trees are found to thrive amidst the air pollution of major cities worldwide.

Many further details are included in *Ginkgo*, including a full description of the Wollemi pine living fossils of Australia (p. 259). The book has dozens of black/white illustrations and 105 pages of appendix, notes, bibliography, and index.

Reference

DeYoung, Don. 2004. *Geology and Creation*. Creation Research Society, Chino Valley, AZ.

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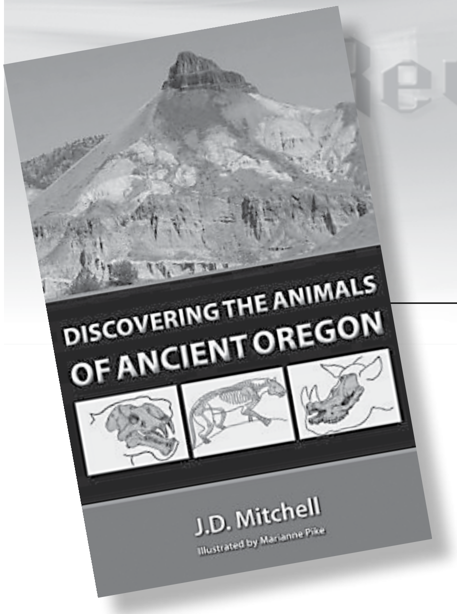

Discovering the Animals of Ancient Oregon

by J. D. Mitchell

Leafcutter Press, Southworth, WA, 2013, 282 pages, $33.95

This book provides valuable insight into many of the key fossils discovered in the eroded hills of the John Day Fossil Beds. These fossil beds are part of the U. S. National Monument in Wheeler and Grant counties in central Oregon near the John Day River basin. There exist over 750 fossil sites within the John Day Basin, a fact that illustrates the importance of the Oregon Monument. Within these locations, researchers have found an estimated 2,200 species of plants and animals. This area is best known for its large number of well-preserved fossil plants and, especially, one of the largest mammal fossil finds in the world.

The focus of this well-written book is an in-depth examination of the major mammal fossils discovered in the John Day area, including cats, dogs, bears, camels, oreodons (a genus of extinct herbivore mammals related to camels and deer), peccaries (an extinct pig), tapirs (a large herbivorous mammal with a short prehensile snout similar in shape to a pig), entelodonts (an extinct family of piglike omnivores endemic to North American forests and plains), and rhinoceroses.

Mitchell also responds to mammal evolution claims. Chapter 14 on horses is especially useful because horses are for historical reasons an icon of evolution. As Mitchell writes, "More words have been written about horse fossils than any other category of mammal fossils" (p. 172). Mitchell then effectively responds to this claim (pp. 172–188). The other chapters successfully refute the macroevolution of other mammals.

Excellent brief biographies of some of the region's earliest and best-known nineteenth-century and early twentieth-century fossil hunters, including O. C. Marsh, E. D. Cope, Joseph Leidy, and the Rev. Thomas Condon, are included to provide the reader with an understanding of how the first fossil finds in this region were rightly or wrongly interpreted. Mitchell then provides an in-depth examination of the fossil evidence for ten fossil families discovered in the John Day area. All of these fossils are examined in the context of a catastrophic flood perspective.

John Day was born about 1770. In 1810, at the age of 40, he joined an overland expedition to establish a fur trading post at the mouth of the Columbia River. The expedition eventually reached the mouth of the Mah-hah River along the Columbia. There, a group of Native Americans stole everything they owned. They were eventually rescued and reached Astoria, Oregon, in 1812, where John Day settled. As a result of this incident, people traveling along the Columbia River called the mouth of the river where Day was robbed the John Day River. By the 1850s, the Mah-hah River was formally renamed the John Day River.

Other chapters cover central Oregon geology and the contributions of Marsh, Cope, Leidy, Condon, and John C. Merriam. An excellent glossary (pp. 257–264), an index (pp. 265–281), and a detailed appendix listing the meaning of taxonomy terms (pp. 253–255), facilitate the book's accessibility to nonprofessionals and professionals alike.

Discovering the Animals of Ancient Oregon is one of the most important paleontological studies of the John Day fossils and those involved in the discoveries there. It is also a good source to refute common examples of mammal evolution. The numerous excellent color photographs, charts, and drawings effectively support Mitchell's thesis and by themselves are well worth the cost of the book.

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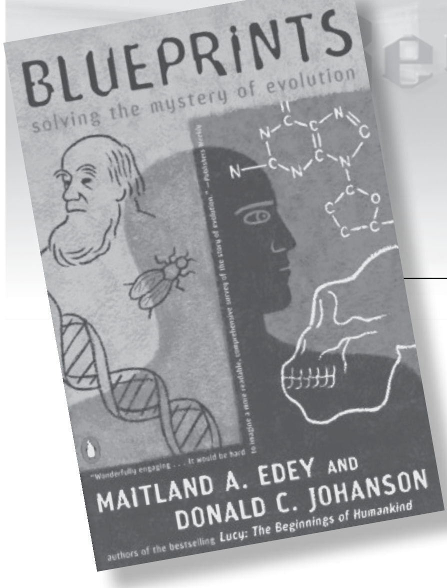

Blueprints: Solving the Mystery of Evolution

by Donald C. Johanson and Maitland A. Edey

Penguin Books, New York, 1990, 418 pages, $10.00

Donald C. Johanson, known for discovering the so-called "Lucy" fossil, is coauthor of this book, along with Maitland A. Edey. They can be commended for two helpful quotes that follow.

"How life's blueprint is assembled and then turned into tissue is one of the most startling and bizarre processes that one could possibly dream of. How on earth did it get going? If the full story of evolution is ever to be told, that question must be answered" (p. 282). Many times we have been told that the origin of life has nothing to do with evolution. Here two prominent evolutionists affirm what I believe: that if evolution is to be believed, then there must be an accounting of life's origin. How does life start spontaneously?

The second quotation reads, "We can even learn something about ancient worms and jellyfish that have left their imprints in mud that has turned to rock" (p. 282). Unwittingly, the authors affirm what creationists believe; namely, as Ken Ham would say, that billions of dead things buried in rock layers laid down by water appear all over the earth testify to a worldwide flood.

On page 371, the authors refer to the supposed "laborious climb upward from simple bacteria forms to the hideously complex organisms." Imagine referring to golden retrievers, tigers, striped bass, and human babies as somehow being *hideous*. My own descriptions would be "marvelous" or "fearfully and wonderfully made." The phrase "simple bacteria" is also oxymoronic. No computer ever made by man is as complex as so-called simple bacteria.

On page 291 the authors write that creationists somehow deny "the existence of fossils." I have known many creationists over the years, but none has denied the existence of fossils. Another misguided quote from page 291: "If our scientific inquiry should lead eventually to God, to questions so large that they cannot be examined coherently, that will be the time to stop science." In contrast, Psalm 111:2 states, "Great are the works of the Lord; they are studied by all who delight in them" (NASB).

Several major topics are discussed in the book: Evolution pioneers, Darwin's Galapagos voyage and writings, unsolved evolution problems, the cell, DNA and RNA, the origin of life, the fossil record, and speciation/extinction.

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Instructions to Authors

Submission

Electronic submissions of all manuscripts and graphics are preferred and should be sent to the editor of the *Creation Research Society Quarterly* in Word, WordPerfect, or Star-Office/Open Office (see the inside front cover for address). Printed copies also are accepted. If submitting a printed copy, an original plus two copies of each manuscript should be sent to the editor. The manuscript and copies will not be returned to authors unless a stamped, self-addressed envelope accompanies submission. If submitting a manuscript electronically, a printed copy is not necessary unless specifically requested by the *Quarterly* editor. Manuscripts containing more than 35 pages (double-spaced and including references, tables, and figure legends) are discouraged. An author who determines that the topic cannot be adequately covered within this number of pages is encouraged to submit separate papers that can be serialized.

All submitted manuscripts will be reviewed by two or more technical referees. However, each section editor of the *Quarterly* has final authority regarding the acceptance of a manuscript for publication. While some manuscripts may be accepted with little or no modification, typically editors will seek specific revisions of the manuscript before acceptance. Authors will then be asked to submit revisions based upon comments made by the referees. In these instances, authors are encouraged to submit a detailed letter explaining changes made in the revision, and, if necessary, give reasons for not incorporating specific changes suggested by the editor or reviewer. If an author believes the rejection of a manuscript was not justified, an appeal may be made to the *Quarterly* editor (details of appeal process at the Society's web site, www.creationresearch.org).

Authors who are unsure of proper English usage should have their manuscripts checked by someone proficient in the English language. Also, authors should endeavor to make certain the manuscript (particularly the references) conforms to the style and format of the *Quarterly*. Manuscripts may be rejected on the basis of poor English or lack of conformity to the proper format.

The *Quarterly* is a journal of original writings, and only under unusual circumstances will previously published material be reprinted. Questions regarding this should be submitted to the Editor (CRSQeditor@creationresearch.org) prior to submitting any previously published material. In addition, manuscripts submitted to the *Quarterly* should not be concurrently submitted to another journal. Violation of this will result in immediate rejection of the submitted manuscript. Also, if an author uses copyrighted photographs or other material, a release from the copyright holder should be submitted.

Appearance

Manuscripts shall be computer-printed or neatly typed. Lines should be double-spaced, including figure legends, table footnotes, and references. All pages should be sequentially numbered. Upon acceptance of the manuscript for publication, an electronic version is requested (Word, WordPerfect, or Star-Office/Open Office), with the graphics in separate electronic files. However, if submission of an electronic final version is not possible for the author, then a cleanly printed or typed copy is acceptable.

Submitted manuscripts should have the following organizational format:

1. Title page. This page should contain the title of the manuscript, the author's name, and all relevant contact information (including mailing address, telephone number, fax number, and e-mail address). If the manuscript is submitted by multiple authors, one author should serve as the corresponding author, and this should be noted on the title page.

2. Abstract page. This is page 1 of the manuscript, and should contain the article title at the top, followed by the abstract for the article. Abstracts should be between 100 and 250 words in length and present an overview of the material discussed in the article, including all major conclusions. Use of abbreviations and references in the abstract should be avoided. This page should also contain at least five key words appropriate for identifying this article via a computer search.

3. Introduction. The introduction should provide sufficient background information to allow the reader to understand the relevance and significance of the article for creation science.

4. Body of the text. Two types of headings are typically used by the *CRSQ*. A major heading consists of a large font bold print that is centered in column, and is used for each major change of focus or topic. A minor heading consists of a regular font bold print that is flush to the left margin, and is used following a major heading and helps to organize points within each major topic. Do not split words with hyphens, or use all capital letters for any words. Also, do not use bold type, except for headings (italics can be occasionally used to draw distinction to specific words). Italics should not be used for foreign words in common usage, e.g., "et al.", "ibid.", "ca." and "ad infinitum." Previously published literature should be cited using the author's last name(s) and the year of publication (ex. Smith, 2003; Smith and Jones, 2003). If the citation has more than two authors, only the first author's name should appear (ex. Smith et al., 2003). Contributing authors should examine this issue of the *CRSQ* or consult the Society's web site for specific examples as well as a more detailed explanation of manuscript preparation. Frequently-used terms can be abbreviated by placing abbreviations in parentheses following the first usage of the term in the text, for example, polyacrylamide gel electrophoresis (PAGE) or catastrophic plate tectonics (CPT). Only the abbreviation need be used afterward. If numerous abbreviations are used, authors should consider providing a list of abbreviations. Also, because of the variable usage of the terms "microevolution" and "macroevolution," authors should clearly define how they are specifically using these terms. Use of the term "creationism" should be avoided. All figures and tables should be cited in the body of the text, and be numbered in the sequential order that they appear in the text (figures and tables are numbered separately with Arabic and Roman numerals, respectively).

5. Summary. A summary paragraph(s) is often useful for readers. The summary should provide the reader an overview of the material just presented, and often helps the reader to summarize the salient points and conclusions the author has made throughout the text.

6. References. Authors should take extra measures to be certain that all references cited within the text are documented in the reference section. These references should be formatted in the current *CRSQ* style. (When the *Quarterly* appears in the references multiple times, then an abbreviation to *CRSQ* is acceptable.) The examples below cover the most common types of references:

Robinson, D.A., and D.P. Cavanaugh. 1998. A quantitative approach to baraminology with examples from the catarrhine primates. *CRSQ* 34:196–208.

Lipman, E.A., B. Schuler, O. Bakajin, and W.A. Eaton. 2003. Single-molecule measurement of protein folding kinetics. *Science* 301:1233–1235.

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

Margulis, L. 1971b. *Origin of Eukaryotic Cells*. Yale University Press, New Haven, CT.

Hitchcock, A.S. 1971. *Manual of Grasses of the United States*. Dover Publications, New York, NY.

Walker, T.B. 1994. A biblical geologic model. In Walsh, R.E. (editor), *Proceedings of the Third International Conference on Creationism* (technical symposium sessions), pp. 581–592. Creation Science Fellowship, Pittsburgh, PA.

7. Tables. All tables cited in the text should be individually placed in numerical order following the reference section, and not embedded in the text. Each table should have a header statement that serves as a title for that table (see a current issue of the *Quarterly* for specific examples). Use tabs, rather than multiple spaces, in aligning columns within a table. Tables should be composed with *14-point type* to insure proper appearance in the columns of the *CRSQ*.

8. Figures. All figures cited in the text should be individually placed in numerical order, and placed after the tables. Do not embed figures in the text. Each figure should contain a legend that provides sufficient description to enable the reader to understand the basic concepts of the figure without needing to refer to the text. Legends should be on a separate page from the figure. All figures and drawings should be of high quality (hand-drawn illustrations and lettering should be professionally done). Images are to be a minimum resolution of 300 dpi at 100% size. Patterns, not shading, should be used to distinguish areas within graphs or other figures. Unacceptable illustrations will result in rejection of the manuscript. Authors are also strongly encouraged to submit an electronic version (.cdr, .cpt, .gif, .jpg, and .tif formats) of all figures in individual files that are separate from the electronic file containing the text and tables.

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Submission of letters regarding topics relevant to the Society or creation science is encouraged. Submission of letters commenting upon articles published in the *Quarterly* will be published two issues after the article's original publication date. Authors will be given an opportunity for a concurrent response. No further letters referring to a specific *Quarterly* article will be published. Following this period, individuals who desire to write additional responses/comments (particularly critical comments) regarding a specific *Quarterly* article are encouraged to submit their own articles to the *Quarterly* for review and publication.

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Occasionally, the editor will invite individuals to submit differing opinions on specific topics relevant to the *Quarterly*. Each author will have opportunity to present a position paper (2000 words), and one response (1000 words) to the differing position paper. In all matters, the editor will have final and complete editorial control. Topics for these forums will be solely at the editor's discretion, but suggestions of topics are welcome.

Book Reviews:

All book reviews should be submitted to the book review editor, who will determine the acceptability of each submitted review. Book reviews should be limited to 1000 words. Following the style of reviews printed in this issue, all book reviews should contain the following information: book title, author, publisher, publication date, number of pages, and retail cost. Reviews should endeavor to present the salient points of the book that are relevant to the issues of creation/evolution. Typically, such points are accompanied by the reviewer's analysis of the book's content, clarity, and relevance to the creation issue.

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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* is a peer-reviewed technical journal. It has been gradually enlarged and modified, and is currently recognized as one of the outstanding publications 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 a research and publication society, and also engages in various meetings and promotional activities. There is no affiliation with any other scientific or religious organizations. Its members conduct research on problems related to its purposes, and a research fund and research center are 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.

iDINO

Investigation of Dinosaur Intact Natural Osteo-tissue

A CRS Research Initiative

Scientists of the Creation Research Society are conducting a project to investigate the presence of intact tissue in dinosaur bones.

In the past several years, different studies have reported evidence of non-fossilized tissue (e.g., compact bone cells) and intact protein remaining inside fossilized dinosaur bones. Since these fossils traditionally have been dated at ages greater than 65 million years, the presence of this non-fossilized tissue is a direct challenge to the entire evolutionary "millions of years" time frame.

As part of the iDINO project, supraorbital horn of a Triceratops has been obtained and analyzed. This analysis revealed intact osteo-tissue containing osteocyte-like structures with detailed filipodial-like interconnections and secondary branching. The intricate detail of these observed cells offers a strong challenge to claims that the tissue is bacterial biofilm or microscopic artifacts. Instead, these results give powerful evidence that dinosaur fossils are really only a few thousand years old.

The Society is seeking funding from interested groups, churches, and individuals. This funding for the iDINO project will enable a more extensive examination of this supraorbital horn as well as other dinosaur specimens.

For more information contact us at (928) 636-1153 or crsvarc@crsvarc.com.

Also visit www.creationresearch.org for project updates and details.

Figure 1. CRS excavation team at a site in Hell Creek Formation, MT. Dinosaur specimens were obtained that have revealed the presence of intact tissue.

Figure 2. CRS team members excavated a Large Triceratops horn at a the Montana site. Analysis of this horn indicates the presence of intact compact bone cells that have not yet fossilized.

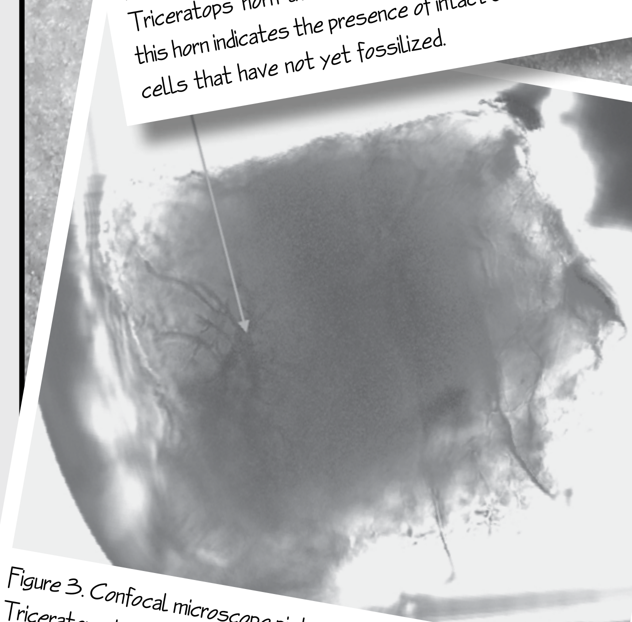

Figure 3. Confocal microscope picture of a thin section of material from Triceratops horn. The arrow points to what appears to be an intact osteocyte cell (a common cell in mature bone). The fluorescence of the cell indicates that it has not yet fossilized.