

Chafer Theological Seminary

# Baloney Detecting

How the Biblical Frameworks Creates Analytical Thinking for  
Evaluating Science Communication

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This paper presents a practical application of Mr. Charles Clough's Biblical Frameworks in a middle school setting for youth to develop critical thinking in their approach to scientific topics. The first section establishes the significance of the Biblical Frameworks ministry and the impact this ministry has had on the author's life. The second section discusses the divine endorsement for scientific inquiry and how this has been altered by modern secular science. In the third section, I discuss the scientific insights of the Biblical Frameworks. The fourth section presents the underlying pagan worldviews inherent to modern day evolutionary theory. In the fifth section, I explain how the Biblical Frameworks addresses gaps in empirical knowledge within the realm of science. Next, I briefly draw the connection between the scientific method and the principles of auditing. In the following section, I provide a critical analysis of science communication, which I've termed: baloney detecting and in the final section, I demonstrate the use of the baloney detecting technique to critique a peer reviewed science journal article.

### Background

My initial encounter with Mr. Charles Clough's Biblical Frameworks ministry occurred at the North Stonington Fall Bible Conference in North Stonington, Connecticut, in 2001. Mr. Clough's presentation was widely promoted within the local Christian community churches. I recall attentively listening as he methodically dissected the weaknesses of the evolutionary argument, addressing one scientific discipline at a time and systematically challenging evolutionary presuppositions.

Mr. Clough's approach was both methodical and engaging. He began by addressing the foundational assumptions underlying evolutionary theories, encouraging the audience to reflect on the philosophical and methodological biases that frequently

accompany scientific inquiries. His proficiency in dissecting intricate scientific concepts and presenting them in a clear and understandable manner was notably impressive.

During the presentation, Mr. Clough provided examples from a range of scientific disciplines such as biology, geology, and astronomy. He discussed how various phenomena, and scientific data could be interpreted differently depending on the perspective taken, including presenting interpretations from a creation worldview. His detailed analysis emphasized the need to critically assess scientific claims and recognize the limitations and assumptions present in any scientific framework.

Mr. Clough's passion and conviction were evident. He had dedicated much of his life to studying the creation/evolution controversy. His confident yet respectful delivery encouraged questions and discussion, fostering a richer exploration of the topics.

Mr. Clough's presentation on Dr. John Woodmorappe's research of the geologic column particularly caught my attention. Dr. Woodmorappe conducted a detailed analysis of all recorded observations of the geologic column across the globe. His findings, which showed the rarity of the presence of the complete geologic column, made me question its existence. Having a background in accounting and auditing, I value thorough supporting documentation, and the inconsistencies regarding how widespread the geologic column, i.e. the average textbook would lead one to believe it is everywhere, you could find it in your own backyard, led me to reconsider its validity.

Mr. Clough's presentation had a significant impact, sparking discussions within the local community regarding the creation/evolution debate. This encouraged individuals, including myself, to delve deeper into the topic through further readings and

lectures. I listened to all 224 lessons in the Biblical Frameworks series and successfully completed the Biblical Frameworks II course offered by Chafer Theological Seminary. Subsequently, I earned master's degrees in Geoscience and Applied Meteorology. Currently, I teach middle school Science and Engineering, where I emphasize critical thinking techniques as outlined in the Biblical Frameworks curriculum.

Reflecting on my experience at the 2001 conference, it was a pivotal moment in my professional journey. It improved my comprehension of the creation versus evolution debate and underscored the vital need to approach such intricate subjects with an open mind and critical perspective. Mr. Clough's presentation remains a highly memorable and influential event in my path toward understanding the depth of the Word of God and its application to science and science published theories.

### Introduction

The natural world is God's creation, and scientific inquiry is a way to understand and appreciate His intricate design and order within His creation. Viewing God's word as the ultimate source of all knowledge is a testament to His wisdom and power, and should be used to evaluate all things, including science.

Science can be broadly defined as the systematic acquisition of knowledge through the examination and analysis of the natural world. In contrast, Applied science pertains to the practical application of scientific knowledge to solve problems and improve various conditions.

Scriptural references indicate that divine endorsement exists for both science and its application. According to Proverbs 8:10, wisdom is highly valued, and Romans 1:20 promotes scientific inquiry into “the things that were made.” Furthermore, Genesis 1:28, often referred to as the Dominion Mandate, commands humanity to exert dominion over the earth, necessitating scientific investigation and resultant applications.

Modern science textbooks assert that the pursuit of knowledge through science is neutral and devoid of supernatural explanations. Such explanations are often viewed as mystical and unnecessary vestiges, discarded by mankind during the enlightenment period. However, approaching science from an allegedly neutral standpoint, by excluding divine revelation, is anything but neutral.

Excluding divine revelation from scientific discourse constrains a comprehensive understanding of science and its applications within the natural world. For example, 2 Peter 3:5-9 speaks to significant geological and meteorological phenomena, stating: “For this they willfully forget: that by the word of God the heavens were of old, and the earth standing out of water and in the water, by which the world that then existed perished, being flooded with water.” This passage not only provides evidence for creation and the worldwide flood, both of which are denied by secular science because of their religious implications, but this passage implies that those who “willfully forget” possess a willfulness to suppress God’s direct revelation. 1 Corinthians 2:14 states that, “the natural man receives not the things of the Spirit of God: for they are foolishness unto him”. Romans 1:18 reveals that there are also those, “who suppress the truth through unrighteousness.” Modern day science communication can be an actual scientist writing about his or her research, which can at times be presented as fact; or a

non-scientist: such as a journalist with no scientific background presenting his or her view on “science”, again often as fact. Willful suppression of God’s truths related to science reveals that there are two ways to view science communication either through the lens of scripture or through unbelief.

### Scientific Insights of the Biblical Frameworks

The foundational principles of the Biblical Frameworks utilize the Word of God to reveal presuppositions and distinguish science from worldview. This approach promotes/reveals a Biblical perspective of science. It also fosters professional skepticism and develops critical thinking regarding science communication. This section provides specific examples from the Biblical Frameworks that form the basis for a comprehensive analysis of science communication from a biblical perspective.

The methodology implemented in the Biblical Frameworks is aligned with the application of 1 Thessalonians 5:21. By testing all things, we are applying critical thinking; we are questioning the science using Scripture as the basis of understanding and exercising the command in 1Peter 3:15, to “defend the truth against those who would seek to discredit it”.

The Biblical Frameworks reveals the underlying pagan worldview that influences modern science. It particularly focuses on the theory of evolution, highlighting the similarities between the ancient doctrine of the continuity of being and contemporary evolutionary theory. Additionally, the Biblical Frameworks examines the replacement of unobservable data with artificial universal constants. It also reveals cognitive biases

within modern scientific communication and presents an alternative Biblical perspective based on scripture. The Biblical Frameworks discusses changes in scientific inquiry and offers examples from various scientific fields to highlight the need to assess whether science communication is truly scientific or ventures into science fiction.

The Biblical Frameworks examines the influence of pagan worldview on contemporary evolutionary theory.

The Biblical Frameworks reference the ancient origin myths held by second-century Babylonians. Enuma Elish, which means “when on high,” is an ancient Mesopotamian creation myth about a battle between gods that occurred at the beginning of time. This historical narrative shows some similarities between ancient and modern pagan beliefs. The Babylonians believed in a continuity of being, where gods, humans, and nature differed only by degree. In their mythology, the Babylonian gods existed in a state of chaos, with supreme authority shifting randomly based on which god was currently the strongest.

In the Mesopotamian creation myth, death was essential for life, with only the strongest gods surviving. Enuma Elish provides early evidence of the pagan concept of the great chain of being, attributing divine qualities like eternity and omnipotence to nature. This idea suggests that order arises from chaos, information from non-information, consciousness from non-consciousness, and life from non-life (Clough, 2013). Darwinian Evolution is remarkably similar, positing that life emerged from non-life through random mutations in an eternal chaos, with death facilitating evolutionary progress by ensuring the survival of the strongest.

A key aspect in understanding both ancient and modern forms of paganism lies in the interaction between Eve and the serpent in Genesis 3:1. The serpent questioned the woman by asking, "Did God really say, 'You must not eat from any tree in the garden'?" Notably, the serpent used the term "Elohim" for God rather than the formal name "Yahweh." Elohim can be interpreted as "god" or "one god out of many gods," whereas Yahweh is the formal name for God, The Lord God (Dean, 2023). This choice of vocabulary reveals the serpent's intent; by using Elohim, he implied that Eve could become a god, like the Elohim he mentioned. It was at this seminal moment in human history, known as the Fall, that Satan introduced the concept of the chain of being (Dean,2023). His implication was that if Eve ate the fruit, she could elevate herself up the chain of being to become like "god." This notion of ascending the chain of being proved irresistible to the man and woman in the garden and has been central to pagan thought ever since.

### The Biblical Frameworks provide insights into addressing gaps in empirical knowledge

God has imbued the natural world with information stemming from divine thought, as highlighted in Psalms 19:1-6 and Job 38-41. Nature contains patterns and forms that reflect the hand of the creator. Paganism, however, attributes these designs to random chance and seeks to generalize the outworkings of nature across time and space. The uniformitarian doctrine relevant to this context asserts that "the present is the key to the past". As Mr. Clough proposes in the Biblical Frameworks, this methodology suggests a claim to universal knowledge while relying on universal constants to resolve uncertainties or hypothesized interpretations of unobserved data (Clough, 2014). Since



the scientific method requires observations, which are not attainable for the distant past or for deep space, universal constants must be used as substitutes for unobtainable observational data. For instance, constants such as radioactive decay rates are presumed to have remained consistent throughout Earth's history. In reality, it is a system of faith to accept presumptions such as these as scientific fact.

A critical aspect of the Biblical Frameworks is the emphasis Mr. Clough places on the lack of empirical knowledge, because human experience is inherently limited. Extrapolating backwards in time or into the future, beyond the scope of human observations requires speculation and conjecture.

In contrast, the biblical view adds additional detail that modern Paganism rejects. Genealogical records suggest that the Earth's age is limited to thousands of years, not millions. It is believed that God's creative processes ceased on the seventh day and do not continue in the present day. The present cannot be used as a reliable key to understanding the past due to the universal geophysical consequences of the fall and the flood. Therefore, the significant impact that these events had on the original creation must be considered. Any use of constants, such as a radioactive decay rate used in radiocarbon dating, must be modeled based on observational data provided during the creation week or possibly as a result of the fall when death and entropy entered the creation (Clough,2014).

## The Biblical Frameworks exposes the weaknesses of Historical Geology

Natural history relies on human observations, records from nature or proxy methods, and interpretations of past events. The evolutionary perspective posits descent with modification and does not suggest the presence of humans during the early evolution of lower life forms. Despite expectations for evidence in the fossil record, substantial gaps remain. Transitional forms, which are critical to evolutionary theory, have not yet been discovered. The current evolutionary theory suggests evolution happened in rapid bursts, too brief to be fully documented in the fossil record.

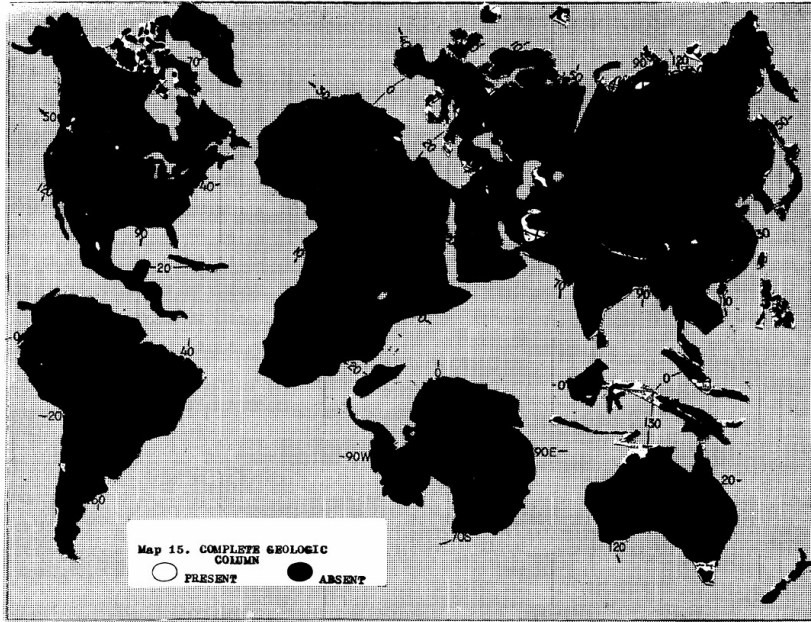
Uniformitarian geologists take pride in their ability to explain the various geological formations around the world through a comprehensive model known as the geologic column. This model is considered a historical record of macroevolution, beginning with lower strata that contain simpler fossil forms and progressing to upper strata with more complex organisms. By applying the principle of superposition, which asserts that the oldest layers are located at the bottom and the youngest at the top, uniformitarian geologists argue that we are observing the Earth's natural history.

Index fossils facilitate the correlation of specific strata with particular epochs of time. This allows rock layers in one location to be aligned with those in another location that contain identical index fossils. The geologic column is constructed from small segments of strata identified in various locations.

The geologic column relies on the sequence of index fossils, which follow an evolutionary pattern. Similarly, evolutionary theory uses the geologic column for reference. Critics of evolutionary theory have characterized this interdependence as

circular reasoning. Nevertheless, uniformitarian geologists rely on index fossils to justify their reliance on the veracity of the geologic column.

The geologic column is often depicted in secular textbooks as an accurate representation, suggesting that the strata layers, although not visible, exist beneath our feet. The Biblical Frameworks references the work of creationist John Woodmorappe, who questioned the accuracy of the geologic column. In 1981, Dr. Woodmorappe conducted a comprehensive analysis of the geologic column, dividing Earth's landmasses into 967 equal areas and reviewing geological literature for reports of sections of the geologic column in each area. The data utilized for this study originated from the work of Ronov et al. which began in the 1950s. Woodmorappe's findings indicate that less than 13% of the Earth's land surface contains five of the ten periods of the geologic column, and less than 1% comprises all ten periods. Notably, these figures include the periods regardless of whether they are in the correct sequence according to the geologic column typically seen in textbooks (Woodmorappe, 1981). Below is the depiction of the geologic column locations as presented by Dr. Woodmorappe. Note that evidence of the complete geologic column is represented by the white specs.



The limited representation of the geologic column observed, both in “correct” and incorrect sequences, has prompted discussions on its existence as traditionally presented. It is important to note that, rather than being considered as absolute truth, the geologic column should be viewed as largely theoretical. At the time of Woodmorappe’s publication, 99% of it had not been directly observed.

Scientists often use statistical analysis to test a hypothesis, a process known as hypothesis testing. This method helps draw conclusions about a data set or sample to determine if the data reliably supports the hypothesis. Various approaches exist for testing a hypothesis about the geologic column as described in science textbooks. However, conducting such an analysis using statistics may not be feasible due to the limited observational evidence available.

Although the data utilized by Woodmorappe in his study of the geologic column is now considered outdated, his work has inspired a new generation of Christian

geologists who continue to provide an alternative perspective, integrating insights from the Bible into the field of geology. By questioning the traditional understanding of the geologic column, these researchers have made new discoveries and developed more accurate interpretations of rock strata, employing advanced technology to analyze and understand these formations as potential evidence of the Noahic flood event.

### Correlating Auditing Principles and the Scientific Method

Auditors and scientists are regarded as distinct professions with differing scopes of practice and expertise. However, auditing is also a scientific discipline that requires a systematic application of professional auditing techniques that are consistent with auditing standards. Both fields share commonalities in their rigorous methodologies for planning, procedures, data analysis, and interpretation. Based on my experience as an auditor, I view data analysis as a process that must adhere to defined, verifiable criteria. Similarly, scientific research and science communication should also undergo rigorous analysis. Every component of the scientific method—including research hypotheses, methodologies, observations, and conclusions—should be verified to ensure accuracy and adherence to the scientific principles.

Both fields involve researching, collecting data, and analyzing evidence to draw logical conclusions. Scientific data is analyzed using various statistical methods such as hypothesis testing, which is a statistical process that uses confidence levels to indicate how well the data represents the hypothesis results. Statistical analysis to draw logical conclusions is common in both fields. Auditing analyzes a sample percentage of data for

compliance with standards and reports significant deviations. What distinguishes auditing is that the evidence required to meet the audit objectives is either available or it is not. If evidence is unavailable and cannot be analyzed, this constitutes a finding. Approaching science communication with the rigor of an audit ensures accountability among authors, requiring them to provide objective evidence. This practice prevents the substitution of facts with personal worldviews and opinions.

### The critical analysis of science communication: Baloney Detecting

People of all ages, education levels, and professions encounter differing views on the origins of life every day. Various perspectives on the creation narrative are presented by the education system, the media, and scientific communities. Media sources often feature reports on new scientific discoveries, hypothetical models, and computer-generated images related to human evolution. Scientific advancements frequently make headlines, sometimes supporting the theory of evolution. Educational textbooks discuss evolution across various scientific disciplines. Additionally, there are debates about climate change, with some attributing changes in atmospheric and oceanic temperatures to human activities. In this era, diverse viewpoints and interpretations are widespread.

How can we discern all the false claims to scientific truth and what standard or process can be used to evaluate them? This is where using the Word of God as the standard of Truth becomes essential. As a middle school science teacher, this process of application is what I refer to as baloney detecting. Baloney detecting is an application

of the Biblical Frameworks that involves critical thinking and applies principles of auditing to evaluate scientific information from a Biblical perspective. The term “baloney” has been an accepted colloquialism for non-sense or something that is categorically untrue.

The phrase “baloney detecting” was used by Mr. Clough in the Biblical Frameworks series and it refers to the use of critical thinking skills used to identify false or misleading information. It was first popularized by astronomer Carl Sagan. Mr. Sagan developed a method of examining evidence, considering multiple perspectives, and applying logic in order to critically assess information. Mr. Sagan’s work is impressive and insightful, but does not use the Word of God as its ultimate authority, therefore, when his critical assessments conflict with the biblical truth, they too become “baloney”.

Mr. Clough, on the other hand, used the term “baloney detecting” throughout the Biblical Frameworks series, but Mr. Clough’s application establishes the Word of God as the ultimate authority. Mr. Clough’s version aims to assist those that may be new to science or those that may not have a formal education in a scientific field, to discern science from science fiction. Science information can be intimidating to comprehend. Many young people and those new to science can possess a certain level of naivete and “awe” regarding science information, making them vulnerable to misleading science communication. Baloney detecting seeks to hold authors accountable for their un-scientific presuppositions that they infuse into their science communication. Baloney detecting also evaluates whether the author is reporting observations by objectively applying the scientific method and assesses the overall communication for the deceptive use of logical fallacies.

One of the objectives of the Biblical Frameworks was to give Christian students confidence when dealing with various pagan worldview philosophies, atheism and open hostility to the Biblical worldview in a college setting. Many young individuals experience a decline in their religious faith during their college years due to the pervasive influence of secular perspectives found in contemporary science communication. Often times they lack the tools necessary to properly discern science from science fiction and fall victim to the atheistic agenda found at many of today's secular universities.

#### Giving my students the tools learned from my own experience

During the pursuit of two master's degrees in the natural sciences, I cultivated a method for assessing scientific information for objectivity and identifying any inherent bias stemming from particular naturalistic worldviews or philosophies. In a graduate school setting, critiquing peer-reviewed science journal articles should be conducted with tact and respect for both the research and the researcher. As Christians, we're commanded in 1 Thessalonians 5:21, to "test all things and hold to that which is good". Evaluating science communication for potential biases, reliability, logical fallacies, and deceptive practices is an essential aspect of the experience for Christian students. This critical analysis can be effectively and consistently applied to all forms of science communication without compromising one's faith.

Upon retiring from the Army, I joined an organization that supplies educators for Christian home-schooled students. I was employed to instruct middle school science and engineering from a Christian perspective. While I possessed my own teaching



resources from my science education background, including Chafer's Biblical Frameworks course, I sought additional materials that were more suitable for middle school students.

In my search for an appropriate textbook and science materials for my General Science class, I came across what appeared to be an excellent resource. At first, I was impressed by the goal of adapting cutting-edge, peer-reviewed scientific research for middle school students and teachers, offered at no cost. However, upon further examination, I discovered that many of their contributing scientists base their research on an evolutionary perspective. The science articles and lesson resources primarily emphasize evolution and climate change. Upon reviewing these articles, it became evident that they often presented speculative content rather than empirical science. The absence of substantial observational data in these articles was particularly notable. The research in question exhibited assumptions that were inclined towards the theory of evolution, and the methodologies employed contained logical inconsistencies. Upon reviewing several articles, I observed that all reinforced the theory of evolution as an established fact and reiterated this claim consistently. It was noteworthy that the articles did not provide observational evidence of evolution yet made assertions of its validity. At times, they invoked the rationale that evolution can occur too rapidly to be observed directly.

Observing that many articles appeared to exhibit bias toward evolution, I noted that the researchers behind these articles, who were part of an international consortium of lifelong evolutionists, often presented observations that seldom aligned with their own conclusions. Additionally, there was a noticeable use of cognitive biases. In light of this,

I assigned a selection of articles to my students as a critical thinking exercise, which I termed “baloney detecting”, a title particularly well-received by middle school students.

Based on the evident weaknesses in the articles, I developed a five-step process for students to critique their articles. While discussing some of the articles with the class, I observed with great interest that students started to recognize the biases, deceptions, and lack of scientific evidence in the articles, despite their numerous truth claims. They were beginning to think critically, distinguishing between genuine science and science fiction.

The 5 steps are:

- Identify the authors and their backgrounds.
- Evaluate the research hypothesis.
- Describe the testing method.
- Summarize conclusions/findings.
- Discuss alternative conclusions/future research.

The first step is to thoroughly research the authors to understand the general focus of their work. Researching the author helps set the expectation for their work, which often aligns with the actual content. The following inquiries should be made regarding the authors: Who are they? What is their country of origin? Are they scientists publishing peer-reviewed research, or are they journalists or others writing about science? Where did they receive their education? What is their field of study? What are their typical research topics and publications? Based on this information, is it possible that they may have a bias toward a particular worldview?

The second step involves evaluating the research hypothesis. It is important to note that not all science communication includes a research hypothesis. Frequently, worldview assumptions are embedded within the hypothesis. These assumptions often lack empirical evidence and may include assertions of belief that are not subject to scientific investigation. Understanding the research hypothesis, if one is present, is fundamental to the process of data collection and testing procedures. The following questions should be considered when assessing the research hypothesis: Is a research hypothesis provided? Does it appear to be biased? Are there any assumptions being made that are not amenable to research?

The critical step is step three, which involves testing the research hypothesis. The scientific method mandates that scientific data be observed and subjected to rigorous testing to ensure it can be verified, validated, analyzed, and replicated. Frequently, universal constants, proxy methods (substitutes), and models are employed instead of direct observations. The utilization of these methods as substitutes for firsthand observations must be clearly distinguished and documented. The observed data, whether presented as a sample or percentage, should be assessed within the context of the entire data set. Particular attention must be given to the numbers and percentages used in this step, as they form the basis for drawing conclusions. When evaluating research testing, I asked my students to consider the following questions: How was the hypothesis tested? Was the scientific method employed? What observations were made? What percentage of the available data was analyzed, and what percentage was not? What were the reasons for excluding certain data? Was there sufficient evidence in the analyzed data to support conclusions? Was technology

utilized in the process? Were there any logical fallacies in the methodology? Are there worldviews present that rely on faith rather than empirical testing?

The fourth step involves evaluating the author's conclusions. These conclusions should logically follow from the research hypothesis through the testing methods and accurately reflect the observations made. One fundamental question to address is if the conclusions are supported by the observations. If the testing or observations do not result in a conclusion, it should be examined whether alternative viewpoints, especially unsupported ones are being presented instead.

The final step involves evaluating whether alternative approaches to the research, including different hypotheses and testing methodologies, could have been employed. Additionally, it is crucial to consider alternate viewpoints based on scripture. Are there any scriptural references that could provide alternative perspectives from a biblical standpoint? This step encourages students to consult the Word of God and consider what the Creator has said in His word that may touch on the area of research.

The Biblical Frameworks approach to detecting biases encourages students to think analytically. It emphasizes evaluating scientific content using Scripture as a reference point. When students notice they are not receiving complete information, their trust in the research and its conclusion diminishes. Incorporating critical thinking into science education is often lacking in current curricula. Educators who focus solely on evolution and treat creation narratives lightly, may discourage critical thinking about evolution. Christian educators should consider the methods used by these teachers of evolution. This aspect could be beneficial, as Christian educators often concentrate solely on presenting creationist viewpoints and in doing so, fail to help students think

through scientific communication outside of the classroom, or when they graduate and attend secular institutions or the workplace.

Throughout my thirty-four-year military career, I was required to study "The Art of War" by Sun Tzu. A key lesson I derived from Sun Tzu's approach to warfare is encapsulated in his quote, "if you know the enemy and know yourself, you need not fear the result of a hundred battles." I made the deliberate decision to enroll in a science curriculum at a public university in order to comprehend the secular perspective. Doing so does not necessitate sacrificing one's faith. On the contrary, I discovered that my graduate studies in science increasingly revealed the presence of the Creator in all scientific disciplines. Combining the diligent study of God's Word with insights from The Biblical Frameworks makes the analysis of science communication more straightforward.

Although critiquing peer-reviewed science journals can be a daunting task, Proverbs 25:15 offers a guiding principle for addressing authorities in secular science: "By forbearance a ruler may be persuaded, and a soft tongue breaks the bone." Holding to this principle is particularly significant within the university setting. Proverbs 15:1 cautions against a lack of gentleness: "A gentle answer turns away wrath, but a harsh word stirs up anger." The primary objective of attending university is to graduate, not to be singled out by faculty who are hostile to a creation worldview, potentially limiting future opportunities. Matthew 10:16 provides further guidance: "be therefore wise as serpents, and harmless as doves." With patience and gentleness, we can fulfill the directive of Matthew 5:14 to be "...the light of the world" within the realm of secular

science. Christians need not fear losing their faith. The following is an extract from a critique on science communication that I conducted during my graduate studies.

### **Spatial and temporal patterns of mass bleaching of corals in the Anthropocene (Hughes et al., 2018)**

The Hughes et al. (2018) study analyzed episodes of repetitive coral bleaching using a judgmental sample of coral geographically distributed between 31 degrees N and S latitude. The study included 100 globally distributed bleaching events that took place between 1980 and 2016 and examined any patterns in timing, recurrence and the intensity of bleaching events.

The authors began by providing background information regarding the significance of the current climatic warming trend, then conclude by attributing regional scale bleaching and mortality of corals to anthropogenic global warming. In their study, Hughes et al. (2018) refer to the discovery of stress bands on the Mesoamerican Reef and assert that these stress bands are both evidence and confirmation of anthropogenic global warming. After discussing the significance of their conclusion, they then explain in detail how and why coral bleaching occurs and make a logical conclusion that climate modeling predicts further bleaching.

Although there were several alternative databases and time spans to choose from, they discuss the weaknesses in the other data bases referenced and declare that their approach avoids any bias caused by continuously adding new sites in open access data bases. They also claim that an additional advantage of their data set is that it

maintains spatial range through time. Finally, Hughes et al. (2018) offer an alarming conclusion that the frequency and intensity of bleaching events are quickly becoming unsustainable due to factors giving rise to the Anthropocene (the age of human induced effects on the environment).

From their data analysis, Hughes et al. (2018) arrived at the following conclusions. The time between severe bleaching events has decreased from once every 27 years to once in every 5.9 years within the time parameters of the data set. They also assert a relationship between global warming contribution to El Niño Southern Oscillation (ENSO) events and global bleaching events. They report that bleaching is taking place in all phases of ENSO, not just the El Niño phase, because sea surface temperatures are warmer today even during La Niña cycles than they were 30 years ago. Due to increased geographic exposure to warmer sea surface temperatures, researchers found that only 6 of the 100 corals sampled had escaped severe bleaching. The authors also conducted a geographic breakdown to uncover patterns in timing, severity and return times of mass bleaching events; identifying the Western Atlantic as the highest risk region. They tested for, but found no significant correlation between the number of bleaching events and the level of postindustrial short term extreme sea surface heating events at each location.

Based on the data analysis described above, Hughes et al. (2018) conclude that anthropogenic climate change will inevitably contribute to an increase in extreme heating events and a decrease in the return times of severe bleaching, surmising that the future of corals depends on the reduction of carbon emissions.

## **Problems / Limitations**

Although the researchers provided adequate justification for the data set selected, there were two significant weaknesses with their selection. First, their argument's center of gravity was focused on recent heating. A study of recent heating is certainly relevant since global temperatures have increased significantly during this timeframe and merits evaluation but they should have included a historical perspective. Other pertinent research by Moritz & Agudo, (2013) addresses the question of climatic changes causing species resilience or decline and calls attention to the fossil record in response to the rapid warming events at the Pleistocene-Holocene transition. According to their research, fossil evidence shows no sign of extinction during a time of significant change, instead it shows shifts in geographic dispersal as species seek optimal temperature bands for survival (Moritz & Agudo, 2013).

Second, data on the total coral population was not mentioned. Readers would like to know what percentage of the total data available on corals was analyzed in this study. We know that 100 sites were selected, but what percentage of the total sites does this study represent? Understanding the sample within the greater context of the total population of corals is important for the reader in order to assign perspective and significance to the work. They did report an apparent limitation in the reliability of data bases to provide accurate data, however, the veracity of the data base they selected for the study was not discussed.

The data analysis was the strongest part of this study, however, the level of certainty in which the authors place on anthropogenic climate change detracts from the article. The authors undoubtedly support anthropogenic forcing but provide little to no



evidence to support their claims. They make reference to other research that supports their stance but fail to include or elaborate on that research or use it to convince the reader of their conclusions. Such a strong stance on a controversial subject should be supported by more detail.

### **Suggestions for Future Research**

When the focus is placed solely on recent observations a study may lack valuable historical perspective, and in this case, a historical heating event was not mentioned. Although the temperature record only goes back to the late 1800's this study does not consider the apparent recovery of corals from previous warming events, such as the medieval warming period. Understanding how the current warming trend compares to that period, if such a comparison can be made, may shed light on risk to and recovery of corals. At a minimum, understanding the contributing factors to and processes by which corals recover, is just as important to understand as what negatively affects them. This would need to be considered within the larger concept of what caused climatic shifts at the Pleistocene-Holocene transition and global warming during the medieval warming period, prior to anthropogenic forcing and would undoubtedly require the use of proxy methods to uncover. The research by Moritz & Agudo 5 (2013) mentioned earlier would provide the basis for this historical approach.

Species survivability related to location parameters offers an area of further research. In a report by Rhode Island's Science and Technical Advisory Board (Science and Technical Advisory Board, 2016) concerning climate change, researchers found that increasing ocean temperatures in Narragansett Bay, Rhode Island are causing cold water species such as cod, winter flounder, hake and lobster to move north out of

Rhode Island waters (Fogarty et. al., 2007) while warm water species such as scup, butterfish and squid are becoming more prevalent (Collie et. al., 2008). When comparing this research to corals, we know that corals require specific conditions to survive and that temperatures are increasing globally. Are corals expanding at higher latitudes (north of 31 degrees N and south of 31 degrees south), or in some cases to deeper depths? What we see in other areas is a shift in sea life due to warming temperatures. Is this not taking place with corals? Are they not expanding into higher latitudes, or deeper depths and shifting like other sea life? Future research should answer these questions.

Another example of natural response and adaptation to environmental changes can be seen in New England's salt marshes, which serve the purpose of flood mitigation, water filtration and provide a habitat for economically and ecologically essential species (Roman, et al., 2016). The referenced salt marshes have seen dramatic change over the past several decades, most importantly they have been submerging due to rising sea levels and attracting flood tolerant species. In order to survive, salt marsh surface elevation and production must keep pace with the rising sea level (Roman, et al., 2016). Other studies have shown that in organic rich salt marshes, elevated CO<sub>2</sub> concentrations may make it possible for coastal salt marshes to keep pace with sea level rise (Carey, et al., 2014). However, in areas with low sediment loads, such as in Rhode Island, it is less likely that these salt marshes will be able to maintain vegetation and productivity as sediments are diluted (Carey, et al., 2014). When we consider research on the adaptation of various sea life, can we expect corals to migrate and adapt as we see happening with other organisms as they adapt to

warmer ocean temperatures and changing ocean chemistry or will they simply become extinct? Future research should answer these specific questions.

To conclude, the larger point to be made here with respect to the Hughes et al. (2008) study is whether or not the present is the key to the past, which is the basis for Uniformitarianism. As scientists, we understand that Earth's current processes, which at times include catastrophic shifts, have operated with relative consistency through observable time. Thermal resilience of marine life is seen in the fossil record through times of catastrophe and change. Thermal resilience is being observed currently, correlating the present and the observable past. Although some may believe that the means of warming may be different today than it has been in the ancient unobservable past, the result today and in the fossil record is that species are resilient and can adapt to survive.

## References

- Carey, J.C., Moran, S.B., Kelly, R.P., Kolker, A.S., & Fulweiler, R.W. (2014). *The Declining Role of Organic Matter in New England Salt Marshes*. *Estuaries and Coasts*, DOI 10.1007/s12237-015-9971-1.
- Clough, C. (2014). *A Biblical Framework For Worship and Obedience In An Age Of Global Deception, Appendix*. 103-128.
- Collie, J.S., Wood, A.D., & Jeffries, H.P. (2008). *Longterm shifts in the species composition of a coastal fish community*. *Canadian Journal of Fisheries and Aquatic Sciences*, 65: 13521365.
- Dean, R.L. (2023). *Lesson 02, Part 2: Pagan View of Origins; Pagan Worldviews*. Interlocked (2023). [02.2 - Lesson 02, Part 2: Pagan View of Origins: Pagan Worldviews - by Robert Dean - Dean Bible Ministries](#).
- Fogarty, M., Incze, L, Wahle, R., Mountain, D., Robinson, A., Pershing, A., Hayhoe, K., Richards, A., & Manning, J. (2007). *Potential climate change impacts on marine resources of the Northeastern United States*. Report to Union of Concerned Scientists.
- Hughes, T.P., Anderson, K.D., Connolly, S. R., Heron, S.F., Kerry, J.T., Lough, J.M., Baird, A.H., Baum, J.K., Berumen, M.L., Bridge, T.C., Claar, D.C., Eakin, C.M., Gilmour, J.P., Graham, N.A.J., Harrison, H., Hobbs, J.A., Hoey, A.S., Hoogenboom, M., Lowe, R.J., McCulloch, M.T., Pandolfi, J.M., Pratchett, M., Schoepf, V., Torda, G., & Wilson, S.K. (2018). *Coral Reefs: Spatial and temporal patterns of mass bleaching of corals in the Anthropocene*. *Science*, Vol. 359, Issue 6371, pp. 80-83. DOI: 10.1126/science.aan8048.
- Moritz, C., & Agudo, R. (2013). *The Future of Species Under Climate Change: Resilience or Decline?* *Science*, 341: 504-508. DOI: 10.1126/science.1237190.
- Science and Technical Advisory Board. (2016). *Current State of Climate Science in Rhode Island: A Report From the STAB to the EC4*. State of Rhode Island Climate Change. May 1, 2016. Accessed March 22, 2020. <http://climatechange.ri.gov/documents/ec4-science-and-technical-advisory-board-report.pdf>.
- Woodmorappe, J. (1981). *The Essential Nonexistence Of The Evolutionary-Uniformitarian Geologic Column: A Quantitative Assessment*, *Creation Research Society Quarterly*, Volume 18, number 1, 46-71.