PERSPECTIVES on Science and Christian Faith

JOURNAL OF THE AMERICAN SCIENTIFIC AFFILIATION

In this issue . . .

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

VOLUME 52, NUMBER 1 MARCH 2000

Perspectives on Science and Christian Faith

MANUSCRIPT GUIDELINES

The pages of *Perspectives on Science and Christian Faith (PSCF)* are open to any contribution dealing with the interaction between science and Christian faith in a manner consistent with scientific and theological integrity. Papers published in *PSCF* do not reflect any official position of the American Scientific Affiliation.

1. All manuscripts (except Book Reviews) should be addressed to: Roman J. Miller, Editor, 4956 Singers Glen Road, Harrisonburg, VA 22802. E-mail: millerrj@rica.net
2. Authors of *Papers* and *Communications* must submit **3 copies** of their paper for review purposes (an original and two copies).
3. Regular Papers should be accompanied by an *Abstract* of not more than 100 words.
4. All manuscripts should be typed double-space on good quality 8½" x 11" paper (computer copies should be printed letter-quality).
5. References and footnotes should be collected at the end. Each note must have a unique number. Accepted manuscripts should follow the *Chicago Style Manual* (14th ed., sections 15.1 to 15.426).
6. Graphics (electronic file preferred) that enhance the theme of the paper are desired. Figures and diagrams not in electronic format should be clear, black and white, line ink drawings or glossy photographs *suitable for direct reproduction*. Captions should be provided separately.

REGULAR PAPERS are major treatments of a particular subject relating science and the Christian position. Such papers should be at least 10 manuscript pages in length, **but not more than 6000 words**, excluding endnotes. Publication for such papers normally takes 9–12 months from the time of acceptance.

COMMUNICATIONS are brief treatments of a wide range of subjects of interest to *PSCF* readers. Communications **must not be longer than 2700 words.** Accepted Communications are normally published in 6–9 months from the time of acceptance.

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BOOK REVIEWS serve to alert the readership to books of interest and provide a valuable source for reference. Readers are encouraged to review books in their scientific fields which have implications for the Christian faith. Guidelines for book reviewers and books available for review are available from the Book Review Editor: **Richard Ruble, 212 Western Hills Drive, Siloam Springs, AR 72761 or E-mail: ruble@tcainternet.com** The viewpoints expressed in the books reviewed, and in the reviews themselves, are those of the authors and reviewers respectively, and do not reflect an official position of the ASA.

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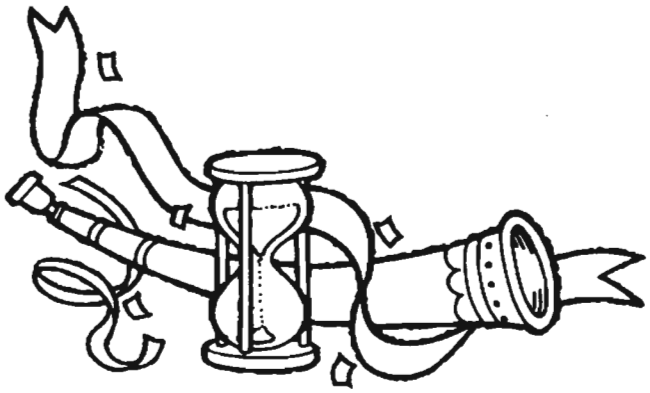
PERSPECTIVES ON SCIENCE AND CHRISTIAN FAITH
(ISSN 0892-2675) is published quarterly for $30 per year by the American Scientific Affiliation, 55 Market Street, Ipswich, MA 01938-0668. Phone (978)356-5656. Fax (978)356-4375.
e-mail: asa@asa3.org
http://www.asa3.org
Periodicals postage paid at Ipswich, MA and at additional mailing offices. POSTMASTER: Send address changes to: *Perspectives on Science and Christian Faith*, The American Scientific Affiliation, P.O. Box 668, Ipswich, MA 01938-0668.

The View from Shepherd's Knoll...



Welcome, New Day!

Greetings! I began my first Mammalian Physiology lecture period at Eastern Mennonite University on January 10, 2000, by welcoming my students to a new millennium (a slight misnomer), a new century, a new decade, a new year, a new semester, a new month, a new week, and a new day for a new biology course! With all of this newness floating around heightened by the changing of the calendar, it motivates me to consider where I am going and how I am walking both personally and professionally.

Consequently, as a new editor I want to share three millennium resolutions: (1) maintain the quality and diversity of published papers; (2) provide a journal wherein readers can discover and develop new insights regarding the interaction of their faith with their scientific work; and (3) shorten the pre-publication time for submitted manuscripts.

My bias tells me that diversified articles representing all areas of science will increase the palatability of our journal to the readership. However, for that to happen, this editor needs submitted manuscripts. In the last issue, I gave a clarion call for reader-submitted papers in several broad thematic areas including Connections, Renewal, Ethics, Science Education, Order and Chaos, and Health and Healing. I hope that my Shepherd's Knoll mailbox will be flooded with creative and investigative articles in these areas!

During the past few days, I did a quick survey of the regular papers published in our journal between 1980–1999. Out of 350 papers, the prominent topics with their percentages were: Philosophy and Theology (29%), Social Science (18%), Creation (15%), History of Science (12%), Ethics (7%), Physical Sciences, Biology, Environmental Science (about 5–6% each) and a small trickle of papers in the areas of Science Education, Geology, Communication, Industrial Science, Computer Science, and Mathematics. Papers that were multidisciplinary in their content were placed within their dominant topic.

The time trends were also interesting. The categories of Philosophy and Theology, Creation, and History of Science had fairly con-

In This Issue

Typically the News & Views section follows the editorial page in our journal. Since we do not have any News & Views articles in this issue, watch the June 2000 issue to read contributions in this section. The Young Scientists' Corner contains an article by Michelle Roth, an undergraduate biochemistry student, who describes her faith journey and her attempts to fit faith and science into her world view.

Our leading regular paper by Peter Zoeller-Greer names God as the Quantum Physicist. For the non-physicists among us (including your editor), Zoller-Greer's lucid explanation of quantum physics lays the groundwork for understanding his interesting insight into a Divine Anthropic Principle. Jerry Bergman uses a design approach to illustrate the superiority of the human eye's pattern. Carol Hill examines present-day geological formations to suggest a locality for the Garden of Eden. Edward Dodson researches the writings of a Jewish author who finds harmony between the Torah and the torah of evolution.

sistent contributions throughout the two decades. A large group of Social Science papers appeared in the early and mid-1980s, then slowed to a trickle, and then practically stopped. The last couple of years we have seen a dribble of social science papers again. I suggest that the underrepresented Affiliation and Commission chairs of our society consider urging their members to submit manuscripts for publication.

In the Communications section, Michael Morris' suggests that altruism is a design plan localized in diverse parts of creation. Following the 1999 Donor List, we conclude our issue with seventeen book reviews categorized into major topics and six letters to the editor.

Jocund Reading.
RJM

Quality reviewers are the life-blood for any journal. A quality reviewer is one who has published papers personally, reads current literature in her/his field of expertise, is knowledgeable about general themes and issues in science and faith, reads submitted manuscripts carefully and critically, gently makes corrections and suggestions that enable authors to improve their manuscripts, discriminates good quality manuscripts from mediocre ones, and returns review forms to the editor before the deadline! *PSCF* needs a few more quality reviewers. My goal for the journal is to respond to authors who have submitted regular papers within three months regarding their acceptance status and then to have these papers in press within a year of the time of their submission. Some of you who currently have papers under review know from experience that this goal is not a current reality!

Newness is a refreshing spring that gladdens the heart, enlivens the mind, and stimulates vision. Yet, new things—scientific experiments and manuscripts—with time become old, worn, decayed, and forgotten. I know of one exception. The Apostle John writes: *"He who was seated on the throne said, 'I am making everything new!'"* (Rev. 21:5, NIV). This passage of Scripture describes our eternal home in the New Jerusalem, a perpetual new place because the Author of Newness is a Creator! Have you ever experienced newness without the erosion of time? ✠

Roman J. Miller, Editor
millerrj@rica.net

Call for Papers

To increase the diversity of articles in *PSCF*, the editor has chosen a thematic approach and invites the submission of manuscripts as regular papers and communications on the following topics:

- **Connections.** Articles dealing with interactions between mind/body, spirit/soul/body, physics/metaphysics, spiritual/material, etc. are requested. Illuminating explanations and insights of functional attachments and interactions between unlike entities are helpful. Deadline for manuscripts: May 1, 2000.
- **Renewal.** A major focus is the physical ecological environment including renewable resources, stewardship, etc. Appropriate inclusions are articles on renewal in other modalities such as living organisms, cellular systems, and psychological or theological realms. Deadline for manuscripts: August 1, 2000.
- **Ethics.** How shall we live and work? Article foci may include such things as medicine, health, environment, professional behavior, education, philosophical foundations, etc. Deadline for manuscripts: December 1, 2000.
- **Science Education, Order and Chaos, and Health and Healing.** Three themes with respective deadlines in 2001: March 2001, July 2001, and November 2001.

All submitted articles should deal with the interaction between science and Christian faith in a manner consistent with scientific and theological integrity. Submitted articles will be peer reviewed. Send manuscripts to: Roman J. Miller, Editor, *Perspectives on Science and Christian Faith*, 4956 Singers Glen Road, Harrisonburg, VA 22802.

Young Scientists' Corner

A View from the Crossroads of Science and Faith

by Michele Roth, Eastern Mennonite University, Harrisonburg, VA 22801

Nearly three years ago, I found myself on a student panel introducing the college I attend to some visiting guidance counselors. Each of us introduced ourselves—I was a biochemistry major, and had chosen to come to Eastern Mennonite University because of its small size, cross-cultural learning opportunities, and reputable science department. One reason that I did not mention was my Mennonite religious and ethnic identity that was deeply changed by four years at a Washington, D.C. area magnet high school. I needed answers. What was all this God stuff really about? Guilt? Social control? The opiate of the masses? What did these big existential questions that I needed to ask say about my abilities? Why were most Mennonites farmers, anyway?

About halfway through the session, an inquisitive guidance counselor leaned back in his chair and asked how I saw cutting-edge science research as congruent with my faith in God. Frankly, I had no idea. Two years into my college career, I still had not found out why Mennonites were farmers. What did this guy think I knew about God? I managed to spout out some drivel about being better stewards of God's creation by seeking to understand it. For that particular audience, my answer seemed satisfactory enough. Over the last three years, however, that question has seldom left me. My attempts to find an answer have sent me paging through my own history, wondering how and why I am drawn to both science and faith.

My insatiable curiosity is perhaps the one part of me that has not changed significantly since I was very young. Much to the consternation of my parents, I habitually awoke early Saturday mornings when I was two or three. Immediately upon getting out of bed, I vividly remember climbing through our study to find a choice remnant of my mother's college years—an old human anatomy and physiology textbook. I would page through until I found some tantalizing detail that I *had* to understand. Sitting on my hands for as long as humanly possible and trying in vain to decipher the text usually gained my mother an extra five minutes of sleep.

"Mommy," I would say, shaking her. "Teach me a-nat-o-my and phys-i-ol-o-gy." I could never seem to comprehend why my mother did not want to get out of bed at five or six in the morning and teach me how the ears worked, or why the baby in the picture had a hole where his nose and upper lip were supposed to be. "But Mommy," I would ask, "where's his nose? *I* have a nose."

Church was the place that I typically had a few friends that were my age. I have very good memories of playing happily at potluck suppers, church retreats, and youth events. My church was very small, with about fifty people present on a given Sunday morning. At the time, it was an active, mainstream-to-liberal Mennonite fellowship where a hefty minority of the members did not grow up as Mennonites. We had families that were core members, and, perhaps because of the transient nature of living in northern Virginia, we had many regular visitors.

A notable event that took place during my intermediate school years was my decision to become a member of the church. I remember being surprised that it warranted such a big event—God had always been real to me. I had seen him in the natural world around me and through the eyes and voices of others in my congregation and my family. It only seemed natural that I would accept his summons. Most of my extended family came to church for the Sunday of my baptism, and I received many wonderfully affirming cards and letters. My mother and I planned the worship service, down to the last hymn. By my request, the pastor's sermon was about mistakes; our pastor spoke as Peter that day.

A large part of my identity, both social and religious, has been with the Mennonite Church.

I have never regretted my decision. Church has provided a sense of family and community in my life that have been invaluable to me. A large part of my identity, both social and religious, has been with the Mennonite Church. I am very grateful for what I continue to learn from my Mennonite kindred about the importance of faith, family, hospitality, and social justice. The sense of history and rootedness that comes from close family and communal ties among Mennonites has also given me a sense of security and relatedness that is extremely valuable and perhaps unusual in postmodern society. Like all family and community relationships, however, some aspects of my relationship with the church have not been as helpful.

Like all family and community relationships, however, some aspects of my relationship with the church have not been helpful.

Since many things in my childhood seemed serious and worrisome to me, perhaps it is only natural that correctly discerning the Word of God seemed an utterly overwhelming, and often terrifying, task. I tried fervently to be a model human being: gentle, responsible, and unselfish. But Sunday after Sunday, I sat in church and silently recounted my sins. I realized all the ways I had fallen short of someone whom I thought would really have Jesus in his or her heart. I also had this troublesome tendency to worry, and would get myself into these cycles of worry, guilt about worrying, and worrying more. I knew that I was supposed to be giving my burdens

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to Jesus, but I just could not let go of them. The additional implicit message that worrying was a good way of caring for my community did not help my conundrum.

I was able to cope with such mixed messages until early adolescence, when the beloved pastor of my childhood left and another took his place a year later. The new pastor's theology carried a variety of negative messages with it that, for me, made church a place of little hope and less comfort. Simultaneously, other events in my life sharply called into question most of my basic assumptions about the nature of God as I understood him.

Events in my life sharply called into question most of my basic assumptions about the nature of God as I understood him.

So I came to college with a lot on my mind. My anxiety and guilt about having such persistent questions about spiritual issues had not abated—the questions had simply become more complex. I also realized that, through my experiences, my views of God and faith had become rather intractably enmeshed with my feelings about the negative experiences of those years. To have any kind of healthy relationship with God, I knew I had to start over. Early in my first year, I jettisoned my old understandings of God and began the long process of rebuilding from ground zero.

I quickly found, however, that one cannot truly start over with such issues. Traces of the old paradigm were manifest everywhere, despite my best efforts to eradicate them. I started by questioning the fundamentals—the existence and nature of God. What was too complex to sort via emotion became an examination primarily by logical faculties. Why do people have faith? Is it love or fear or conditioning? I did not feel God. Why did I not if everyone else around me could? Why are we so literal about some parts of the Bible and more or less ignore other areas? Is faith really something other than accumulated tradition? My church nearly always characterizes God as male. Does that mean that my gifts as a female are less valuable? Mostly to protect myself, I became an expert at pointing out the holes, the hypocrisies, and the inconsistencies in Christianity as I saw it.

Early in my first year [at college], I jettisoned my old understandings of God and began the long process of rebuilding from ground zero.

Puritanism bothers me. It makes Christianity into a big yardstick, next to which we stack up an aspect of someone's life (sexuality, or perhaps correct beliefs, or maybe abusive behavior) and start pointing fingers about who is in and who is out of the Kingdom of God. In other words, we marginalize those who have issues that make us uncomfortable. Jesus ate with the most despised of his society. Women, prostitutes, and tax collectors were among his followers. He repeatedly rebuked religious leaders for their attention to Levitical purity codes, wealth, and pretentiousness, while they did nothing about weightier matters such as easing the burden of the poor. Why, then, do Christians maintain partisan attachments to these very same outward attributes? I am certainly not advocating that wrongdoing should be ignored. I just think the Church must relinquish its judgmentalism about the issues involved. All of us are unconditionally children of God. In my opinion, it is long past time to stop pointing fingers and start talking about how to love and nurture those whom we would rather forget.

In truth, I am still seeking. My hope is that this journey will not end. Maybe I am attached to both faith and science because their

intersection lies in the unending search for knowledge and truth. However, the reality of living as a Christian and as a scientist is more formidable to me. I wonder if one can strive for achievement and definition by the standards of the scientific community and still maintain primary allegiance to God. Will publications, grants, prestige, and my *curriculum vitae* define my life? Will I even admit to my own idolatry? Am I so intent upon doing my Christian duties that I arrogantly fail to listen to the inconsistencies in my own faith?

It is probably quite evident by now that I have many more questions than answers. However, I like to think that I have *begun* the process of learning what I need to learn. Thus, I offer some of my musings as closing thoughts. First, I need not attempt to hold the future with an ironclad grip, nor need I worry that what I have accomplished in the past is not enough. I have been where I needed to be then. Secondly, God is the only legitimate judge of humanity, and given support, I believe we can all hear God's voice and be changed accordingly. My mandate is to live by befriending my "enemies"—those with whom I fundamentally disagree. If the friendship is real, my opinions will be solicited (and heard) eventually. Finally, at the point that I become comfortable with God, the mystery ends; the doubt ends; my faith ends. Where there is certainty in my life there is no place for faith; it becomes meaningless. To have true faith, I must also have doubts. ✠

Maybe I am attached to both faith and science because their intersection lies in the unending search for knowledge and truth.

Books Received and Available for Review

(Please contact the book review editor if you would like to review one of these books. Please choose alternate selections.) Contact Richard Ruble, Book Review Editor, *Perspectives on Science and Christian Faith*, 212 Western Hills Drive, Siloam Springs, AR 72761 or ruble@tcainternet.com

Roy Clouser, *Knowing With The Heart: Religious Experience and Belief in God*, IVP, 1999
Lawrence W. Fagg, *Electromagnetism and the Sacred: At the Frontier of Spirit and Matter*, Continuum Pub. Co., 1999
Stanley Fish, *The Trouble With Principle*, Harvard University Press, 1999
Roy Gallant, *Early Humans: The Story of Science*, Benchmark Books, 2000
Donald Goldsmith, *The Runaway Universe: The Race to Find the Future of the Cosmos*, Perseus Books, 2000
Dan Graves, *Doctors Who Followed Christ: Thirty-two Biographies of Eminent Physicians and Their Christian Faith*, Kregel Publications, 1999
David Gushee, (Ed.), *Toward and Just and Caring Society: Christian Responses to Poverty in America*, Barker Book House, 1999
D. G. Hart, *The University Gets Religion: Religious Studies in American Higher Education*, John Hopkins, 1999
Thomas Hart, *Spiritual Quest: A Guide to the Changing Landscape*, Paulist Press, 1999
John Hitchcock, *Healing Our Worldview: The Unity of Science and Spirituality*, Chrysalis Books, 1999
James Humber & Robert Almeder, *Is There A Duty To Die?* Humana Press, 2000
Erazim Kohak, *The Green Halo: A Bird's-Eye View of Ecological Ethics*, Open Court, 2000
Martin Lockley, *The Eternal Trail: A Tracker Looks at Evolution*, Perseus Press, 1999
John Oswalt, *Where Are You God? Malachi's Perspective on Injustice and Suffering*, Evangel, 1999
Richard Petersen, *New Insights to Antiquity: A Drawing Aside of the Veil*, Engwald, 1998
William Poundstone, *Carl Sagan*, Henry Holt, 1999
Paul Rabinow, *French DNA: Trouble in Purgatory*, Chicago, 1999
Lester Stephens, *Science, Race, and Religion in the American South*, North Carolina Univ. Press, 2000
Ray Tallis, *The Explicit Animal: A Defence of Human Consciousness*, St. Martin's Press, 1999
Eugene Taylor, *Shadow Culture: Psychology and Spirituality in America*, Counterpoint, 1999
James Thrower, *Western Atheism: A Short History*, Prometheus Press, 2000
Evan Walker, *The Psychics of Consciousness: The Quantum Mind and the Meaning of Life*, Perseus Books, 1999

Genesis, Quantum Physics and Reality

How the Bible agrees with Quantum Physics — An Anthropic Principle of Another Kind: The Divine Anthropic Principle

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Yea, if thou criest after knowledge, and liftest up thy voice for understanding; If thou seekest her as silver, and searchest for her as for hid treasures; Then shalt thou understand the fear of the LORD, and find the knowledge of God —Prov. 2:3–5, KJV.

Recently many discussions (mostly between scientists and theologians and even among scientists and fellow scientists) have focused on how the reports in Gen. 1:1ff will or will not contradict actual scientific realms. They begin with the evolution theories and lead to the cosmological theories of the big bang. The point I would like to make here includes aspects of the interpretations of quantum physics. As we will see, these aspects could make the other discussions superfluous. Indeed, this interpretation of reality seems to be foreseen in the Bible and supports a transcendent Creator. The Bible seems compatible with quantum physics and even leads to a new kind of anthropic principle: the Divine Anthropic Principle. God seems not only to be a mathematician, as some say; he also seems to be a quantum physicist.

Quantum Physics in a Nutshell

Most physicists agree that quantum physics is one of the most important physical theories in history, even more important than Einstein's theory of relativity. And the latest results of experiments in the field of quantum physics seem to solidify this view. Let us say in advance that up to now there is not one single phenomenon which contradicts this theory. This is unique in physics. Even the strange results of the subsequent, described experiments are fully predicted by quantum mechanics!

Physics normally makes a distinction between an observable phenomenon (e.g., an apple falls from a tree) and its mathematical description by the observer (e.g., $s=\frac{1}{2}gt^2$). The assumptions and formulas are called a "model." Such a model is called "good," if it can make predictions that can be verified by experiments. If such a model fulfills certain criteria, such as simplicity (in a mathematical sense) and consistency with the observed world, physicists then accept it.

With quantum physics, however, a new problem has risen within physics. It concerns the distinction between the observer and the observed phenomenon. The formula $s=\frac{1}{2}gt^2$, which describes the distance "s" performed by the falling apple during the time span "t" (where $g = 9.81 m/s^2$), is used by the *observer*, and the influence of the observer in relation to this phenomenon can be neglected. But if a physicist tries to observe very small elementary particles such as electrons or photons (light particles), this influence can no longer be neglected. In fact, this influence usually is so big that it will destroy the measured results.

For example, consider the following problem. To measure the locality of an electron and its speed (actually its impulse, to be more specific) at a certain time, we can try to "look" at the electron with light. But a photon shot at the electron to determine its location and speed will alter the position and the actual speed of the electron in such a way that its former simultaneous location and speed can never again be precisely reconstructed. As shown by the German physicist, Werner Heisenberg in 1927, this is not a question of how "good" your measuring equipment is; it is a fundamental law called the "Heisenberg Uncertainty Principle." So the position and speed of an electron (and any other elementary particle) can simultaneously be determined *only* within a *boundary of uncertainty*. In general, impulse and locality cannot be measured with arbitrary accuracy at one time. There is a fundamental lower limit.

Yet, consider that our whole universe is made out of such elementary particles. Another problem is that the border between the *observer* and the *observed object* is not fixated. If a photon "observes" an object, who observes the photon? If this is a human eye, who observes the human eye? Is it the nerve skein connected with the eye? At the end of the nerve, is it a brain cell? So, who *is* last in this chain of observers? Which "entity" is aware of all this? Where is this entity located?

The problem of "who observes whom" is crucial. On the other hand, if a system is not observed, it is also "undisturbed" and behaves in a different way. This can be seen within the Wave-Particle Dualism. Every elementary particle (remember, all matter in the universe is made out of such particles) behaves either as a wave or particle, depending on the equipment used to "observe" it. For example, under certain circumstances, a photon behaves as a wave. Everyone can see the "color" of light. This can easily be interpreted as the frequencies of light waves. On the other hand, light is also able to "shoot out" electrons onto certain metal surfaces (e.g., photo cells). But only (light) particles, capable of enough energy, are able to do this. (Einstein won his Nobel Prize for this discovery.) So, what is light (and all matter)? The question here is, "Is light made up of waves or particles?" The answer is, "Neither." As long as light is not observed, it is a kind of unification of both called a *quantum system* (no one knows what it *really* looks like, because we just assume it is not observed). Only when and as we observe it, does it "behave" either as a wave or as a particle, depending on the measuring equipment used. The same is also true for our former "unobserved" electron. As long as no one "looks" at it, it is a quantum system with no certain location and impulse at one time. Yet, if we look at it, we can only find out *either* its exact location *or* its exact impulse, but not *both* exact values at the same time.

Let it be noted that *mathematically* the quantum system is precisely described through the solutions of the so-called "Schrödinger equation"; the corresponding solutions (called "wave-functions") are a superposition of all possible outcomes. If the so-called quantum system is "disturbed," e.g., by observation, then the wave-function "collapses" and one of the former possible outcomes becomes the solution of the Schrödinger equation (that is what we call "reality").

Thus, the problem can also be described as follows: What we normally call "reality" is the result of

Peter Zoeller-Greer was born in 1956 in Mannheim, Germany. He studied mathematics and theoretical physics at the University of Siegen and later at the University of Heidelberg from 1975 to 1981. In 1981, he received his M.A. in mathematics from the University of Heidelberg. From 1981 to 1987, he worked as a computer researcher at ABB Mannheim and from 1987 to 1993, as a lecturer at several colleges. In 1990, Zoeller-Greer received his Ph.D. from the University of Mannheim for a mathematical solution to a quantum mechanical problem. Since 1993, he has been professor of mathematics and computer science at the University of Applied Sciences in Frankfurt am Main, Germany. He is a member of the "Professorenforum," an Association of German University Professors, who have declared to support the Christian faith at German Universities.

collapsed wave-functions. The question is, "What kind of 'reality' corresponds to the 'un-collapsed' wave-functions, that is, how 'real' is a physical state described by the superposition of possible 'realities'?" Therefore *this* (un-collapsed) "reality" is an abstract notion with no concrete meaning.

In the example of the observation of an electron, we can reduce the interpretation of this behavior to two viewpoints:

a. There is (in *reality*) a definite location and an impulse below the Heisenberg uncertainty limit, but we cannot measure them simultaneously.

b. There *is* simply *no* location and impulse below the Heisenberg uncertainty limit (or, in other words, there is no reality for the electron's impulse and location below this limit; its reality is created only during its observation).

In other words, according to (a) there *really is* a world "out there," independent of the fact that we are observing it, while according to (b) the interpretation is that there is *no reality* "out there" (at least it makes no sense to talk about it) as long as we do not observe it (that is, reality is "created" during the process of observation). The latter is also well known as the "Copenhagen Interpretation" given by Niels Bohr in the 1920s.

Although it seems a little far-fetched to say that reality only exists while observed, many scientists tried to conceive experiments, whose results would lead to a clear decision between the two interpretations. Two major experiments, one performed by Alain Aspect during the 1980s[1] and one by Marlan Scully and his research team in the early 1990s,[2] gave results even more staggering than expected. Both experiments have to do with the Wave-Particle Dualism of a photon. I want to give a rough overview here of the Scully experiment, to show how important its results are.

A light beam enters a crystal, which divides every photon into two so-called "twin photons" with lower intensity (see Fig. 1). The twin photons are directed in separate directions, each of them reflected by a mirror and later "united" by a semi-transparent mirror (50% of the photons can pass through, the other 50% are completely reflected and therefore cannot pass through). Behind this mirror are two detectors that can register each photon.

Scully's arrangement of the components is made so that the twin photons unite in a way that at one time, one twin photon is reflected and the other one passes through the semi-transparent mirror or vice versa. In either case, as a result, a reunited, "whole" photon (with the original intensity) is detected either at the upper or lower detector. This represents

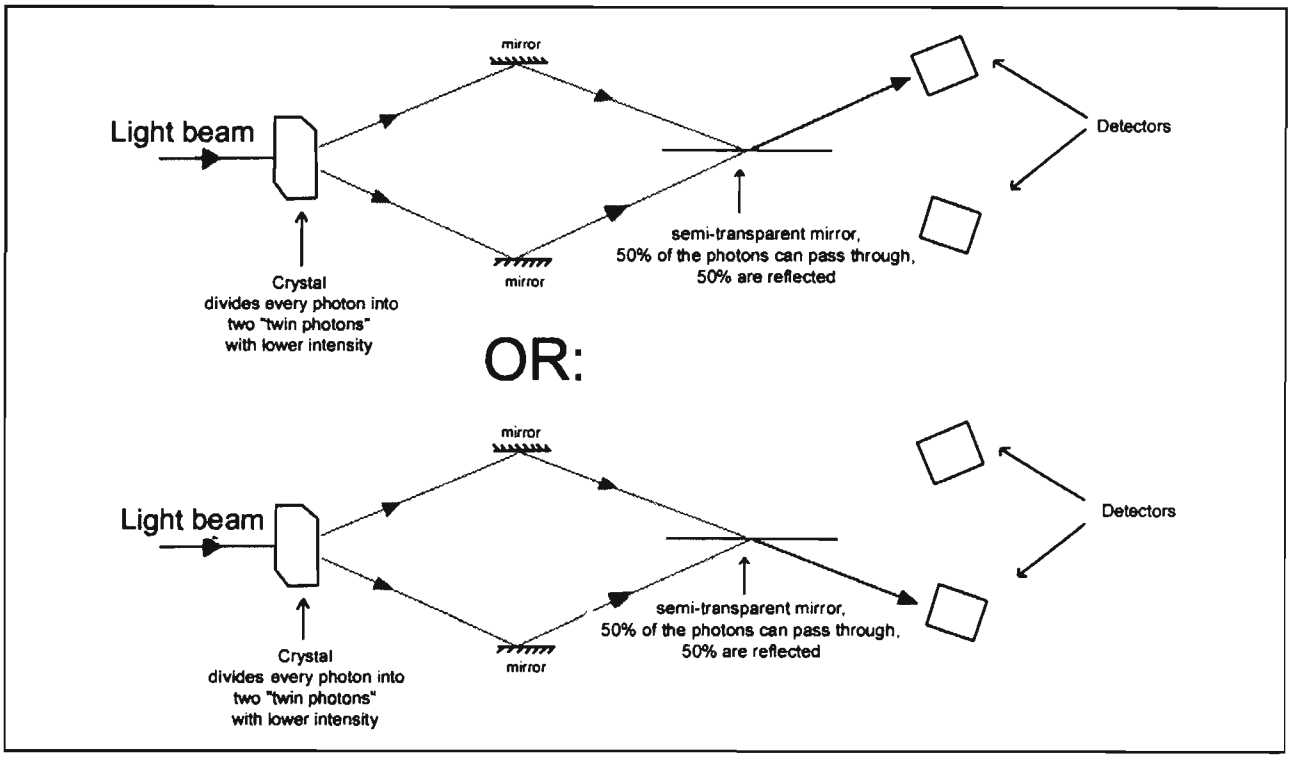

Fig 1.

the "wave-behavior" of photons and the effect is called "interference."

Next, Scully and his team were interested in finding out which way each of the two twin photons went before they were reunited at the semi-transparent mirror. So they "marked" one of the twin photons with a so-called polarization filter, an optical device that slightly "twists" the photon beam. In doing so, the photons "feel" observed and thus their wave-behavior is destroyed. Suddenly, Scully and his team detected not only "united" photons, but also "single" twin photons at the upper and the lower detector at the same time (see Fig. 2).

But what happens if two other polarization filters are set up directly in front of the detectors, which are adjusted in such a way that "behind them" the information of which photon is marked (that is, polarized) is deleted? (See Fig. 3).

Here is the amazing result. Since the information has been destroyed (concerning *which* photon went which way), the photons no longer "feel" observed and, therefore, as in the "undisturbed" experiment (without any polarization filters), only "reunited twin photons" are detected, *either* at the upper *or* lower detector. So, the twin photons unite again at the semi-transparent mirror in such a way that either the one twin photon is reflected and the other one passes through or vice versa.

But wait a minute. How could the two twin photons know that *behind* the semi-transparent mirror (this means *later* in time) a device is waiting that destroys the information of the first polarization filter and that for this reason the twin photons reunite at the semi-transparent mirror? Can the photons foresee the future? Or does our measurement (that is, observation) influence the past? If there is an independent reality "out there" (this means, independent from the observer), how could these results be explained? In fact, they could not! At least, with no "reasonable" explanations.

Still some scientists tried to do this. For instance, they declared the existence of so-called "parallel-universes" that exist at the same time and are often very similar to our universe. In this model (founded by Hugh Everett in 1957), according to our experiment, there are (at least) two universes: (1) where, at the semi-transparent mirror, the twin photons are reunited and take the upper *or* lower way, and (2) where they stay separated and take *both* ways. Thus,

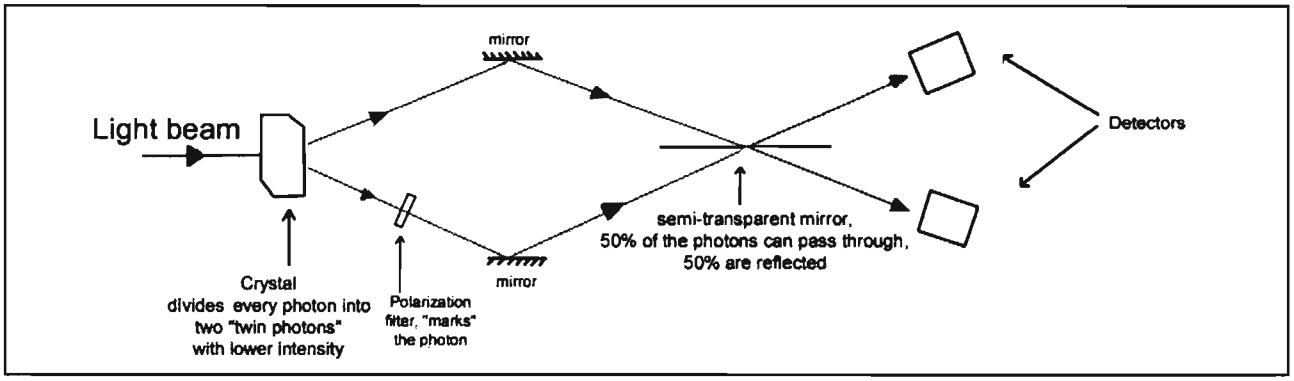

Fig. 2.

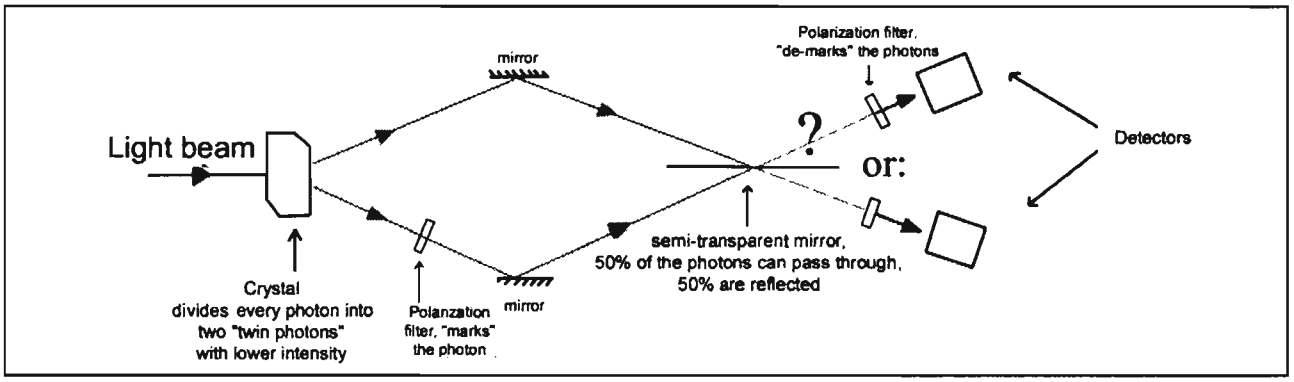

Fig. 3.

both universes are supposed to have a true reality, and at the very moment we "look" at the result of our experiment, we decide which of the two universes we are "slipping" into (the one with the appropriate past).

But many scientists feel that it is unscientific to invent objects (like multi-universes) ad hoc, which could never be directly observed, only for the purpose of justifying a physical model or explaining the results of an experiment. Another group of scientists hope one day to find so-called "hidden variables" that will connect the observed photons registered at the detectors with the twin photons, which are supposed to unite "in the past" at the semi-transparent mirror. The problem with this is that, in the whole realm of physics, there is not one single example (up to now) of variables that can "influence" an event in the past from the present. This too seems a very "artificial" way, and again, it is only justified by its purpose, to explain the results of Scully's experiments.

Another point is the "observer-chain" mentioned earlier. The who-observes-whom problem leads to an infinite regress. In this case, some scientists conclude that there *has* to be an observer "outside" the universe, because otherwise the problem of how a universe could exist without an observer is unsolvable. Guess who this outside-the-universe observer could be!

Now, a critic could say that the time-span between the semi-transparent mirror and the detectors is so short that the influence into the past can be ignored.[3] However, this is no real argument, because in a way a "Scully-like" experiment can be stretched to cosmic dimensions! (Actually, the following is a cosmic version of the classical two-slit experiment.) Fortunately, there is a cosmic constellation that destroys this argument.[4]

A so-called "quasar," a pulsating light source, "hidden" behind a big galaxy is visible on earth by "bending" its light around the galaxy, billions of light years away (see Fig. 4). This is possible, because according to Einstein's theory of relativity, a large mass (like a galaxy) could work as a gravitational lens and therefore bend the light around itself. So the light of the quasar is "doubled" by the gravitational lens, that is, one beam comes from the right side of the galaxy to us, and the other beam comes from the other side.

Simply put, an experiment on Earth can be made in such a way that it determines if one photon comes along either on the *right* or the *left* side or if it comes (as a wave) along *both* sides of the gravitational lens at the same time. However, how could the photons have known billions of years ago that someday there would be an earth with inhabitants on it, making just this experiment? Or do we "influence" the past "out there" billions of years ago through our observations here in the present? Hardly imaginable! In addition, let us assume that different scientists here on Earth perform two experiments of this kind at the same time. One experiment is arranged in such a manner that the light beams pass both sides of the gravitational lens and the other experiment "forces" the beams to pass either on the one side or the other. What follows? Are there two different pasts for each observer at the same time? This is *big trouble* for the multi-universe theory and for the "hidden-variables" approach.

Let it be noted that the older experiment of Alain Aspect was similar. His purpose, however, was not to determine if an observation could "influence" the past, but to discover if the observation of one of the two twin photons could influence the other one through space instantly, even at a great distance. The result was that they could, with no time loss! But this finding contradicts Einstein's special theory of relativity, where the speed of light is the absolute speed-barrier. While some scientists' hope of ghostly "hidden" variables capable of instantly transporting information from one photon to the other was understandable, the existence of variables that can transport information back in time seems

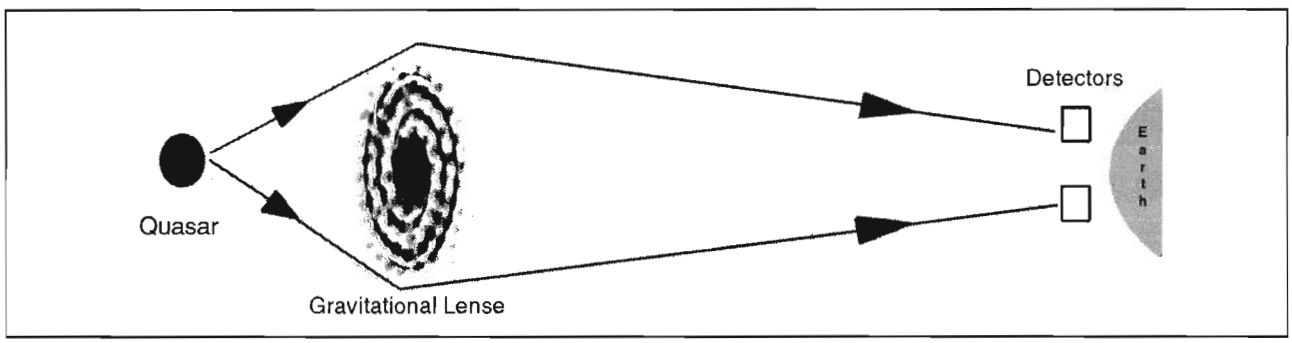

Fig. 4.

ridiculous. So it is no wonder that these scientists now feel a certain angst because of the possible loss of their *weltbild* (world view).

Some may say that quantum physics, with all its strange results, does not matter in the macroscopic world, since all the problems described above deal only with elementary particles. And indeed, in the macroscopic world, we do not seem to have the problems mentioned here. But this is not *really* so. First, as I stated earlier, everything in our universe is made out of elementary particles. Secondly, quantum mechanics is not only applicable to elementary particles, quantum mechanics can also be accurately applied to macroscopic objects. A well-known example of strange behavior, even in our macroscopic world, is given by "Schrödinger's Cat."[5] And furthermore, phenomena seem to exist in the macroscopic world that are not explainable with classic physics. For example, some physicists try to explain certain ESP phenomena with quantum physics.[6]

The assumption that our macroscopic past is not effected by the Heisenberg Uncertainty Principle is not as clear as often postulated.

Others say that the conscious human is not crucial for *reality*, because a photographic plate could substitute for the observer. Of course, this is not a valid argument, because, as corresponding experiments show, the results come into being (reality) when the photographic plate is observed by a human being. So, this is only another example for the already described "observer-chain," since the time-point of the observation is only delayed to the observation of the plate.

Therefore, the assumption that our *macroscopic* past is not effected by the Heisenberg Uncertainty Principle is not as clear as often postulated. Who can say for sure what the "past" of our universe looked like if one *does not* look at it, e.g., through telescopes? One may have many similar questions, as for example: "How far is it possible to extrapolate from Scully's quantum mechanical bench-top experiments to the classical world of the past?" "Is such an extrapolation troubling for sciences such as geology or astrophysics?" Because of limited space, it is not possible to answer these questions in this paper, but much material concerning such questions can be found in Wheeler's "Law without Law."[7]

So, what remains? Obviously, only the "old" Copenhagen Interpretation, which leads to the assumption (simplified) that the observer during his observation creates that reality. Without an observer, there seems to be no "reasonable" reality "out there." But what does all this have to do with the Bible?

The Bible Connection

Let us consider the creation report in Gen.1:1–31. There we have the following events:

1. Creation of heaven and earth, light, and day and night.
2. Creation of land and water.
3. Creation of plants and fruit trees.
4. Creation of stars, sun, and moon.
5. Creation of fish and birds.
6. Creation of animals and humans.

Evolutionists complain that, as stated in the Bible, the sun and moon were created *after* the plants and trees, and because of this, they say, that the creation report cannot be (literally) true. Let us consider the following: According to the results of experiments, we now know that reality (at least as we observe it) is a "construct" of our interaction with it, that is, no one could really say what this reality "looks like" without our observation. And, as we have already seen, this even seems to be true for events that took place in a "past reality." So, what can we *really* say about any events of a past that were not observed by any human being (that is, before the existence of humankind)? We can only say that our "reconstruction" of the past is an image that obviously depends on our present observation of it. So the question, "What did the past *really* look like?" cannot be answered accurately as long as no observer was there.

Remember that the Scully experiment teaches us that the past (of the electron's decision about "how" to unite at the semi-transparent mirror) was created during its observation in the present. But we also understand that this reconstruction of the past leads us to more than one possibility. The past's reality "happens" while it is being observed in the present, and the kind of observation even determines what the past looked like. But according to the Bible, the creation of humans was the "last" event of the creation period, so this was the first time a conscious observer came into being. This is important to remember.

After seeing the famous movie, "Gone With the Wind," one knows which events took place. At first, there was the announcement of the Civil War, then there was the war with all its destruction, meanwhile there was a love story going on, and after the war, the famous "Frankly, my dear, I don't give a ... !" scene took place. But was this *really* the order of the filmed sequences? Of course not! As everybody knows the sequences were filmed in an order suitable to logistic and organizational demands. If, for instance, a person is to appear only three times during the whole movie, let us say at the start, in the middle, and somewhere toward the end, then it would be easier (especially if the actor is costing the movie company lots and lots of money!) if these scenes were filmed at one time. Later these sequences are inserted at the proper position in the movie, even if "years" lay in between (according to the plot).

... our "reconstruction" of the past is an image that obviously depends on our present observation of it.

Or let us take the TV-series, *Star Trek* (the one with Kirk & Spock, etc.). After this series was on the air, authors "constructed" a matching past to the series, and wrote, e.g., about Spock's youth. So, *in the present*, a possible, "reasonable" *past* was created for Spock, which led to the "reality" of the stories of the series in a logical way. This reconstruction could be called an "extrapolation" from the present into the past. However, there could be more than one possibility for Spock's past which matches the TV-series! But remember, in *reality* (in the series), there was no "past" of Spock *at all*. Furthermore, Spock "exists" only if someone looks at one or more of the *Star Trek* series or movies. Thus, Spock exists only by observation, not in reality! And as we know from the movie, *The Truman Show*, even the reality of a "real" person can be a total fallacy.

Now, what do scientists do, when they are talking about a past where boldly no human has gone before? They are talking about an extrapolation of the present (of humankind) with three possibilities:

1. The extrapolated past could have *really* happened this way.
2. Another "reasonable" past could have happened.
3. There was no *real* past at all (at least no kind of past that we can imagine or talk about).

According to the results of Scully's experiments, only the third interpretation seems to make sense! But even the scientists, who believe in the "many-world hypothesis" must agree that there could be an infinite number of past "realities" that may lead to the same present world (depending upon our observation of it).

So, what remains? Obviously, only a "movie" we call reality, and an extrapolation postulated by some scientists of one of many possible pasts which may (or may not) match our present observation of this reality.

The Bible says:

"He [God] has made everything suitable for its time; moreover he has put a sense of past and future into their minds, yet they cannot find out what God has done from the beginning to the end" —Eccles. 3:11 (NRSV).

Now consider that the Bible is talking of a *sense* of past (and future), and God has put it into our *minds*. As the Scully experiments seem to tell us, we are not able to *find out* what God has *really* done, that is, know how the universe really "works" (at least with physics). Does the reality of our past exist *only* in our minds? Since CNN was not there with their camera teams, we can only produce a mathematical calculation of this past. Here is another example from the Bible that shows us how we possibly may have to deal with the experimental results.

"Thou shalt not make unto thee any graven image, or any likeness [of any thing] that [is] in heaven above, or that [is] in the earth beneath, or that [is] in the water under the earth: Thou shalt not bow down thyself to them, nor serve them: for I the LORD thy God [am] a jealous God ..." —Exod. 20:4, 5 (KJV).

The "graven image" [Exod. 20:4] could also be the model a scientist makes of the universe.

According to the newest results, these verses now may stand in a brand-new light. The "graven image" could also be the model a scientist makes of the universe. Perhaps the Bible foresees the impossibility to complete the chain of logical conclusions within our *weltbild* based on such graven images. Obviously, severe contradictions arise if traditional

reasoning is applied to the newest results of quantum physical experiments, like the ones done by Scully. This fits perfectly with the following Bible verses in an amazing way:

"Every man is brutish in [his] knowledge: every founder is confounded by the graven image: for his molten image [is] falsehood, and [there is] no breath in them. They [are] vanity, [and] the work of errors: in the time of their visitation they shall perish" —Jer. 10:14, 15 (KJV).

One could quite provocatively say that the classical image of the universe, constructed by the "founders" called scientists, breaks down. It seems to be a "work of error."

One could quite provocatively say that the classical image of the universe, constructed by the "founders" called scientists, breaks down. It seems to be a "work of error." What is now happening to a lot of scientists can be expressed perfectly through another verse from the Bible:

"They shall be turned back and utterly put to shame—those who trust in carved images, who say to cast images, 'You are our gods'" —Isa. 42:17 (NRSV).

The "god" of solid, deterministic reality, describable by physics and understandable by reasoning and "common sense," may very well have to be sacrificed. As in the above verse, our knowledge turns out to be foolish. This development may also be foreseen in the book of Isaiah:

"Thus says the LORD, your Redeemer, and He who formed you from the womb: "I am the LORD, who makes all things, who stretches out the heavens all alone, who spreads abroad the earth by Myself; Who frustrates the signs of the babblers, and drives diviners mad; Who turns wise men backward, and makes their knowledge foolishness" —Isa. 44:24, 25 (NKJV).

Last, but not least, "the making of their knowledge foolishness" is prophesied for the End Times and astonishingly matches these verses in the Bible:

"But know this, that in the last days perilous times will come: For men will be lovers of themselves, lovers of money, boasters, proud, blasphemers, disobedient to parents, unthankful, unholy, unloving, unforgiving, slanderers, without self-control, brutal, despisers of good, traitors, headstrong, haughty, lovers of pleasure rather than lovers of God, having a form of godliness but denying its power. And from such people turn away!

"For of this sort are those who creep into households and make captives of gullible women loaded down with sins, led away by various lusts, always learning and never able to come to the knowledge of the truth. *Now as Jannes and Jambres resisted Moses, so do these also resist the truth: men of corrupt minds, disapproved concerning the faith; but they will progress no further, for their folly will be manifest to all, as theirs also was"*
—2 Tim. 3:1-9 (NKJV, emphasis mine).

Another Anthropic Principle?

For a moment, let us put aside the problem of the *reality* of the past without an observer and turn instead to classical physical views.

It has only been a few years since physicists found out that the values of our nature constants are crucial for our existence.[8] If, during the Big Bang, some values would only differ by 0.000000000001%, the resulting universe could never yield any biological life. Even conservative mathematical estimations show that the probability for the existence of a life-bearing universe is at least $1:10^{229}$,[9] this number is:
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If one holds to the position that the universe came into existence without a Creator, who deliberately "fine-tuned" these nature constants in such a way that biological life could appear, then this is a position where one is betting against the most unlikely and the most highly and extreme odds. Furthermore, if one estimates the possibility for some kind of life form to appear within the universe, then—corresponding to the evolution theories—the probability that an *intelligent* life form will appear (we assume humans are intelligent) is much worse (over 400 zeros after the "1" of the denominator). Thus, it is quite clear that scientists ask the question, "Why do we observe these special values of the nature constants?"

Now, the usual anthropic principle says (simplified) that the universe evolves (deliberately) in such a way that sooner or later an intelligent life form will arise who will "appreciate" it, that is, who could observe it and try to understand it. This is a

kind of pantheistic world view (*pantheism* says that God is identified with the universe and its phenomena, and is bound by the laws of nature). There are different variations of this principle, like WAP (weak anthropic principle), SAP (strong anthropic principle), PAP (participatory anthropic principle), and FAP (final anthropic principle).

These views, however, do not help us understand the results of Scully's experiments. So I will try to formulate an anthropic principle of another kind. But I surely do not want to add another CRAP (completely ridiculous anthropic principle). Therefore, to distinguish my position from all the pantheistic versions of the usual anthropic principle, I would like to call it the "Divine Anthropic Principle" (DAP).

Physical reality is no longer a thing "out there," it is something that needs two things: an observer and an observable object.

We surely can say that we exist ("I think, therefore I am"). What the "we" is, is not evidently clear (consider the infinite regress mentioned earlier). But as we now know, this "we" is responsible for the outcome of our reality (the "we" decides how our experiments are chosen and, therefore, what reality "looks like"). Thus, our reality is, in a sense, "created" by our observation. The past could only be defined through our remembrance. Therefore, past is what we remember. The question, whether our remembrance is "true" or "real," is meaningless. Let us call this remembrance (or past) our "path" or "way" as the Bible calls it. This path appears rather subjective. None of our paths are identical. Even two "different" pasts can occur (see the description of the cosmological analogy of the Scully experiment). There is no "unique" past, the past depends on the observer. Therefore, scientifically speaking, no special past has more reality than any other, so *the* "real" past simply does not exist (in this physical sense). Furthermore, and this is the intrinsic message, *there is no "real" past at all, if there are no observers* (see also the PAP).

To make one thing clear: "There is no real past ..." does not absolutely exclude *any* past at all, but it should be understood in relation to a (human) observer. Physical reality is no longer a thing "out there," it is *something* that needs *two* things: an observer and an observable object. Thus, once again, *physical* reality is what mathematicians call a "relation." Without an observer, we simply *cannot say anything* (in a physical, that is, "real" way) about any past. This is what we call "no *real* past." And this leads us to the "divine" part of this Divine Anthropic Principle.

Again, "past reality" is subsequently created by an (intelligent?) observer; this means created by *that* which we named our "we" in the above statements. So, who can tell us what the universe *really* looked like before the creation of the first conscious human beings according to the Genesis report (see day 6)?

As we find in Genesis 1, it took six days to create the universe, including the earth and human beings. Thus, the first five days are beyond human observation. So according to the former considerations, these five days are a *kind* of past that we would not regard as "real" in our physical definition. But, as I mentioned, this certainly does not mean that this past did not take place. As we have seen, the word "real" (in physics) only makes sense in relation to a *human* observer. The "reality" of God is surely something totally different and completely incomprehensible, and it is even unimaginable for us. But there is no reason whatsoever to doubt the description given in the Bible concerning the creation account of the universe. Since God cannot lie (Tit. 1:2), we must assume that the Genesis report is true. So now we can distinguish between the kind of past that has a "reality" (since the sixth day) and the "other" past that occurred during days 1 through 5. This "other" past is just as true as the past after the sixth day, but it is a "divine" past, "unreachable" through our physical reality. Furthermore, quantum physics not only supports this view, it also supports the possibility for God to act within our reality.

The word "real" (in physics) only makes sense in relation to a* human *observer.

The Bible says:

"Now therefore, stand still, that I may reason with you before the LORD concerning all the righteous acts of the LORD which He did to you and your fathers"

—1 Sam. 12:7 (NKJV).

According to quantum physics, God is also able to interact effectively with our (observable) reality. As John Polkinghorne stated in his book, *Belief in God in an Age of Science*,[10] the Heisenberg Uncertainty Principle offers almost infinite possibilities

for God to interact on a subatomic level with tremendous results on our physical reality in the macroscopic world.

Furthermore, here is another point which agrees with Genesis: God provided Adam with a free will. But according to classical physics, especially according to Newton's mechanics, there is no room for a free will, since the universe was "only" seen as a kind of clockwork, and God's position in it was restricted to the winding up of the clock, and then the clock was "left to itself."

We can distinguish between the kind of past that has a "reality" (since the sixth day [of creation]) and the "other" past that occurred during days 1 through 5. This "other" past is just as true as the past after the sixth day, but it is a "divine" past, "unreachable" through our physical reality.

Now, with quantum physics, God can interact with reality through the Heisenberg Uncertainty Principle, and he can also enable human beings to make "true" decisions. These decisions are not determined in advance by the current state of the universe. So the old dilemma of living in a calculable universe and having a free will is also solved (although God is, of course, omniscient concerning all events that occur in the universe).

We have seen that, even from a scientific viewpoint alone, Genesis 1 is just as good as any other possible "path" for our past beyond humankind. And, according to classical physics, there still remains the highly improbable and unlikely absurd ratio that seems to lead rational and logical thinkers to a "deliberately" fine-tuned universe. But when Genesis 1 is seen in the new light of the Divine Anthropic Principle along with the improbable appearance of conscious human beings, this makes Genesis the most likely "past" for the search for truth that is supported by actual physical observations and laws.

For God said:

"Trust in the LORD with all thine heart; and lean not unto thine own understanding. In all thy ways acknowledge him, and he shall direct thy paths"

—Prov. 3:5, 6 (KJV).

"The LORD by wisdom hath founded the earth; by understanding hath he established the heavens"

—Prov. 3:19 (KJV).

"Jesus said to him, 'You shall love the LORD your God with all your heart, with all your soul, and with all your mind'" —Matt. 22:37 (KJV). ✠

Notes

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Is the Inverted Human Eye a Poor Design?

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It is often claimed that the human retina is poorly designed because it appears to be placed in the eye backwards. Its design, therefore, requires that light travel through the nerves and blood vessels to reach the photoreceptor cells located behind the eye's wiring. We now know that specific functional reasons exist for this so-called backward placement of the photoreceptors. A major reason for the retina reversal is that it allows the rods and cones to interact with the retinal pigment epithelial cells that provide nutrients to the retina, recycle photopigments, provide an opaque layer to absorb excessive light, and perform other functions. This design is superior to other systems, because it allows close association with the pigmented epithelium required to maintain the photoreceptors. It is also critical in both the development and normal function of the retina.

A major argument for the existence of a Creator is called the Argument from Design. Proponents claim that the design existing in creation proves the existence of an Intelligent Designer. Darwinists try to disprove this observation by providing examples of what they claim is poor design in order to demonstrate that the natural world is in fact not designed, but is the result of blind, natural, impersonal forces. This view is called the *blind watchmaker* thesis by Dawkins.[1] One of the most common examples of poor design used by Darwinists is the human retina. A common claim made in both the popular and scientific literature to support the blind watchmaker thesis is that the vertebrate eye is functionally suboptimal because the retina photoreceptors are oriented *away* from incoming light.[2] Dawkins explains why he considers this an example of poor design:

> Any engineer would naturally assume that the photocells would point towards the light, with their wires leading backwards towards the brain. He would laugh at any suggestion that the photocells might point away from the light, with their wires departing on the side *nearest* the light. Yet this is exactly what happens in all vertebrate retinas. Each photocell is, in effect, wired in backwards, with its wire sticking out on the side nearest the light. The wire has to travel over the surface of the retina, to a point where it dives through a hole in the retina (the so-called 'blind spot') to join the optic nerve. This means that the light, instead of being granted an unrestricted passage to the photocells, has to pass through a forest of connecting wires, presumably suffering at least some attenuation and distortion (actually probably not much but, still, it is the principle of the thing that would offend any tidy-minded engineer!). I don't know the exact explanation for this strange state of affairs. The relevant period of evolution is so long ago.[3]

Williams claimed the retina is not just *an* example, but one of the *best* examples of "poor design" in vertebrates, proving that the blind watchmaker, not an intelligent creator, created life. He notes:

> ... Every organism shows features that are functionally arbitrary or even maladaptive ... *My chosen classic is the vertebrate eye.* It was used by Paley as a particularly forceful part of his theological argument from design. As he claimed, the eye is surely a

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> superbly fashioned optical instrument. It is also something else, a superb example of maladaptive historical legacy. The retina consists of a series of special layers in the functionally appropriate sequence. A layer of light-sensitive cells (rods and cones) stimulate nerve endings from one or more layers of ganglion cells that carry out initial stages of information processing. From these ganglia, nerve fibers converge to form the main trunk of the optic nerve, which conveys the information to the brain. All layers are served by blood capillaries that provide their metabolic requirements. Unfortunately for Paley's argument, the retina is upside down. The rods and cones are the bottom layer, and light reaches them only after passing through the nerves and blood vessels (emphasis mine).[1]

Williams admits that the vertebrate eye still functions very well despite the backward retina design, but argues that this fact does not negate his basic argument. He says:

> ... the fact of maladaptive design, however minimal in effect, spoils Paley's argument that the eye shows intelligent prior planning, and the visual effect is real and routinely demonstrable.[2]

This topic is of great interest to creationists. As Diamond notes:

> [of all of our features] none is more often cited by creationists in their attempts to refute natural selection than the human eye. In their opinion, so complex and perfect an organ could only have been created by design. Yet while it's true that our eyes serve us well, we would see even better if they weren't flawed by some bad design. Like other cells in our bodies, the retina's photoreceptor cells are linked to a network of blood vessels and nerves. However, the vessels and nerves aren't located behind the photoreceptors, where any sensible engineer would have placed them, but out in front of them, where they screen some of the incoming light. A camera designer who committed such a blunder would be fired immediately. By contrast, the eyes of the lowly squid, with the nerves artfully hidden behind the photoreceptors, are an example of design perfection. If the Creator had indeed lavished his best design on the creature he shaped in his own image, creationists would surely have to conclude that God is really a squid.[3]

Thwaites argues that the inverted retina problem hits at the *core* of the design argument, and that historically the design argument was a major basis of theism. He says:

> Another example straight out of creationist tracts involves the vertebrate eye that humans must share with the other vertebrates ... the vertebrate eye shows poor design when compared to the eye evolved by the cephalopods. The vertebrate eye has a blind spot where the retinal nerves and the blood vessels exit the eye. There is no comparable blind spot in the cephalopod eye. The structures of the retinas spell the difference. Everything a vertebrate sees is seen through the nerves and blood vessels of the retina since the photosensitive elements of the retina are on the far side of the retina away from the light source. Clearly the cephalopod solution to retinal structure is more logical, for they have the photosensitive elements of the retina facing the light. Certainly the creationists need to explain why we got the inferior design. I had thought that people were supposed to be the Creator's chosen organism.[4]

Williams adds that "our eyes, and those of all other vertebrates, have the functionally stupid upside-down orientation of the retina" and that the "functionally sensible arrangement is in fact what is found in the eye of a squid and other mollusks."[5] An evaluation of this argument reveals it is not only naive but grossly erroneous.

The so-called inversion of the retina is considered a suboptimal design primarily due to its simplistic comparison with a camera. In Diamond's words, "placing the rods and cones at the bottom layer and requiring light to pass through the nerves and blood vessels is the opposite of how a sensible engineer would have designed the eye." He adds "a camera designer who committed such a blunder would be fired immediately."[6] And Edinger concluded: "The vertebrate eye is like a camera with the film loaded

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backward ... if an engineer at Nikon designed a camera like that, he would be fired."[7] This conclusion is based not only on the assumption that placing nerves and blood vessels in *front* of the retina reduces the retina's overall effectiveness but that another design as a whole would be superior.

Retina photoreceptors that face the eye lens are called *verted*, and photoreceptors that face the back of the eye are called *inverted*.[8] Verted eyes are wired so the photoreceptors face *toward* the light and the nerves are placed *behind* the photoreceptor layer.[9] Most invertebrates possess a verted-type eye; most vertebrates (including mammals, birds, amphibians and fish) possess an inverted-type eye. Most verted eye types are very simple, although a few types, such as the cephalopod eye (squids and octopus), are almost as complex as the vertebrate eye. Verted eyes tend to be functionally inferior, a conclusion usually determined by measuring performance in response to visual stimuli. Even the better verted eyes are still "overall quite inferior to the vertebrate eye."[10]

In contrast to the claims of Dawkins et al., no evidence exists to support the claim that even the most advanced verted eye is superior to the inverted eye.

The most advanced invertebrate eye is that of certain cephalopods.[11] The major anatomical difference between the human eye and the advanced cephalopod eye, such as the octopus, is the retina, which is not only verted but also lacks a fovea centralis. As an underwater animal which usually lives on the ocean bottom, the eye of the octopus is designed to detect motion, not detail as is true of human eyes, and must maximize its utilization of light since the ocean usually has little or no light at its lower depths. Barnes notes:

> The cephalopod eye undoubtedly forms an image, but the animal's visual perception is certainly quite different from that of man, which is greatly dependent upon interpretation by the brain. The cephalopod optic connections appear to be especially adapted for analyzing vertical and horizontal projections of objects in the visual field.[12]

The visual system used by cephalopods is poorly understood partly because understanding it is not a funding priority and partly because it is so complex. Meglitsch notes: "The cephalopods have the most highly developed nervous systems to be found in invertebrates, and correspondingly complex behavior patterns."[13]

In contrast to the claims of Dawkins et al., no evidence exists to support the claim that even the most advanced verted eye is superior to the inverted eye. As Ayoub asks:

> [Would] "hundreds of thousands of vertebrate species—in a great variety of terrestrial, marine and aerial environments—really see better with a visual system used by a handful of exclusive marine vertebrates? In the absence of any rigorous comparative evidence all claims that the cephalopod retina is functionally superior to the vertebrate retina remains entirely conjectural."[14]

Judging by physiology, the verted cephalopod retina is clearly inferior to the inverted retina. Wells notes:

> Compared with the vertebrate retina, the retina of Octopus is very simple. There are no equivalents of amacrine, bipolar or ganglion cells in the cephalopod; peripheral processing of the visual input must be much simpler.[15]

The octopus eye also contains a complex nerve plexus posterior to the receptors.[16] Wells adds that the optic lobes must assume many of the functions of the inverted retina in vertebrates so that the "apparent relative simplicity of the cephalopod system is an illusion. It is a matter of stacking; amacrines, bipolars and ganglion cells are all there, but stuck onto the outer layer of the optic lobe rather than onto the back of the retina."[17]

Pechenik indicates that although cephalopods can perceive shape, light intensity, and texture, they lack many of the advantages of an inverted retina, such as the ability to perceive small details.[18] The visual system of the cephalopods is designed very differently than the inverted eye in other ways to enable them to function in their dark, water world. They can see only in black and white and have a narrow range of vision compared to humans. Their photoreceptor cell population is composed of only rods, and they contain a mere twenty million retina receptor cells compared to 126 million in humans.[19] The rod's outer segments contain *rhodopsin* pigment that has a maximum absorption in the blue-green part of the spectrum (475 nm), which is the predominant color in their environment. Photons change the rhodopsin to metarhodopsin and no further breakdown nor bleaching occurs.[20]

A second pigment in the octopus, *retinochrome*, has an absorption maximum of 490 nm, which is more sensitive to dim light. It evidently serves a supplementary role in the octopus vision system.[21] Humans have one rod type and three cone types. One cone type has a light frequency of 430 nm (blue), another 530 nm (green), and the other 569 nm (red). Further, in bright light the cephalopod's pupils become thin and slit-shaped, and are held in a horizontal position by an organ called a *statocyst* that uses gravity to determine the horizontal.[22] Evidently they scan a thin but wide area for information, indicating that their visual world is considerably different from that of humans.[23]

Grzimek notes that their visual process is "quite similar to that of the batrachians, reptiles and insects. A 'photograph' of the recorded image is not traced on the retina as in man; instead cephalopods record and interpret as stimuli (pattern recognition) only light and color variations of a moving object."[24] Importantly, the octopus "will respond to certain motions as if they were prey, but will not react to his normal food-objects when they are motionless."[25] This observation of the importance of motion in vision function is in harmony with the observation that the octopus eye can be called "a compound eye with a single lens" for the reason that the receptor cells are surrounded by microvilli which form rhabdomeres.[26] Each facet in a compound eye is either on or off, and object movement produces a change in the on-and-off pattern, similar to how a series of light bulbs produces the illusion of movement by changing on-and-off patterns.

How the eye evolved from the primitive verted type common to invertebrates into the inverted eye of vertebrates is ... an unexplained mystery. No evidence exists of any transitional forms, and all known animals have either verted or inverted eyes.

Our ignorance about the function of major parts of the cephalopod visual system, such as the optic lobe, prevents researchers from completing a more detailed analysis of cephalopod vision. How the eye evolved from the primitive verted type common to invertebrates into the inverted eye of vertebrates is also so far an unexplained mystery. No evidence exists of any transitional forms, and all known animals have either verted or inverted eyes. Prince notes:

> [one of the essential and] most important differences between vertebrate and invertebrate eyes is that in the former the receptors point outwards towards the choroid, whereas in invertebrates they mostly point inwards towards the lens. But for that obstacle we should have been deluged with theories on the original evolution of the vertebrate eye from the invertebrate. As it is, vertebrate visual origins have to be approached with great caution, and ... there is nothing indisputable which can be used to explain the origins of the vertebrate eye from an invertebrate organ.[27]

The common solution, convergent evolution, suffers from major problems and will be discussed elsewhere.

Functions of Rods and Cones in Vertebrates

To understand the critical function of the *retinal pigment epithelium* (RPE), the chemical process required for vision must be briefly summarized. The *rods* and *cones* are photoreceptor cells located in the retina that transduce light into electrical signals. Rods and cones are cells that contain most of the organelles that cells normally require, including mitochondria, Golgi complexes, a nucleus etc. So-called black-and-white transduction occurs in the rod-shaped receptors, and color transduction occurs largely in the cone shaped receptors.[28]

The inverted retina vision system requires light to first pass through the cornea, then through the anterior chamber filled with aqueous fluid, then through the lens, and then through the vitreous humor fluid. Finally, before reaching the retina, light passes through the inner cell layers of the retina, past the rod and cone photoreceptors, until it reaches the far posterior or distal end of these cells, wherein lie the so called *outer cell segments*. See Fig. 1.

The outer segment membrane in cones folds back and forth in a pleated fashion, and in rods the pleats pinch off to form close to 1,000 separate disks piled up like neatly stacked pennies. The outer cell segments contain the photoreceptor light-sensitive structures including the *visual pigment*, also called the *photopigment*. The photopigment is where the transduction of light into receptor potentials occurs.

The photopigments consist of a family of proteins that undergo physical changes when they absorb light energy. The principal component of photopigments is the *opsin* glycoprotein, a derivative of *retinal*

(a modified *vitamin A* molecule). Vitamin A is derived from *carotenoids*. For this reason, good vision requires a diet high in foods that contain abundant carotenoids, such as carrots, spinach, and broccoli. Lack of vitamin A produces night blindness or *nyctalopia*. Rods contain a single photopigment type called *rhodopsin* (*rhodo* meaning *rose* and *opsis* meaning *vision*). The cones contain one of three different kinds of photopigments called iodopsins: (1) *erythrolabe* (which is most sensitive to red light), (2) *chlorolabe* (most sensitive to green light), and (3) *cyanolabe* (most sensitive to blue light).[29] Color vision occurs due to small variations in the amino acid sequences of these different iodopsins, which enable the rods and cones to differentially absorb wavelengths of incoming light.

Vision functions by a change in the retina photopigments molecule caused by light. The molecule has a bent shape (*cis*-retinal) in darkness, and when it absorbs light, isomerization occurs and the molecule becomes the 'straight' form (*trans*-retinal). This causes several unstable intermediate chemicals to form, and after about one minute, *trans*-retinal completely separates from opsin, causing the photopigment to appear colorless (for this reason, the process is called *bleaching*). So that the disk rods or cones can again function for vision, retinal must be converted from *trans* back to the *cis* form. This resynthesis process called *regeneration* is aided by the *pigment epithelium* cells located next to the rod and cone outer segments.

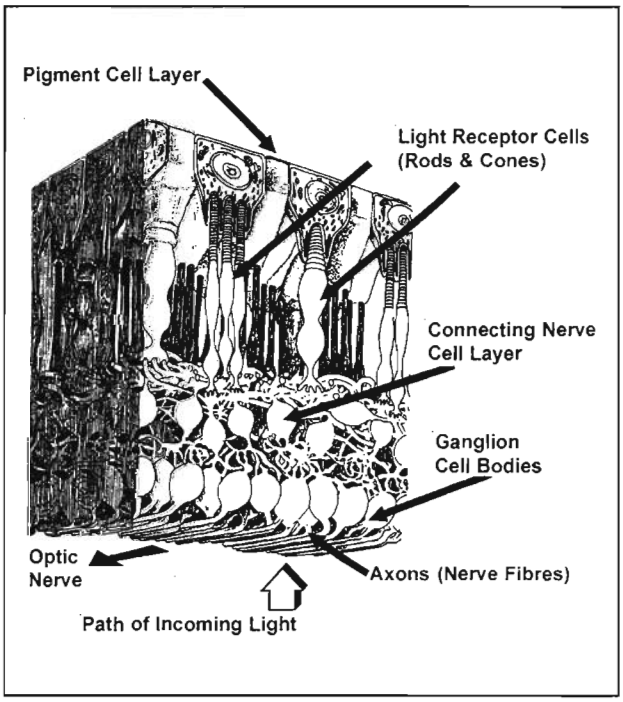

Fig. 1. A cross section of the back of the eye showing the retina pigment epithelium and other structures of the retina. Note the structures that the light must pass through before striking the rods and cones. *Drawing by artist Richard Geer.*

Vision functions by a change in the retina photopigments molecule caused by light.

Cone photopigments regenerate more quickly than do the rhodopsins and consequently "are less dependent on the pigment epithelium."[30] A half-life of about five minutes is required for rhodopsin regeneration in the rods compared to 1.5 minutes for iodopsin regeneration in cones. Excessive light will cause blindness in the effected rods and cones until this regeneration process occurs. Common examples of this phenomena include temporary blindness after watching a very bright light flash, such as from a strobe-light or photocopy machine.[31]

When rods and cones are stimulated by light, they release neurotransmitters that induce graded, local potentials in both bipolar and horizontal cells. By this means, the rod and cone outer segments transduce light into electrical signals. The signals are carried by the central nervous system neurons to bipolar cells, which in turn synapse with the ganglion cells, then to the *lateral geniculate body* of the thalamus and other centers in the brain stem, and, lastly, to the primary visual center in the occipital lobe of the cortex where the signals are interpreted by the brain.

The first level of processing visual information actually occurs by the amacrine cells, which transmit information between adjacent bipolar cells and ganglion cells, allowing lateral communication in the outer retina for a comparison of information. Retinal amacrine cells help to process visual information by enhancing certain aspects and discarding other aspects of visual input. Input from several cells can either *converge* upon one postsynaptic neuron or *diverge* to several post synaptic neurons. Convergence dominates to the degree that in humans about 126 million photoreceptors send their information to only about one million ganglion cells.

A single cone tends to synapse with one bipolar cell whereas between six and 600 rods synapse with a single bipolar cell. The cones' one-to-one synapses give them much higher visual acuity but lower sensitivity. In contrast, rods are extremely sensitive to

light but their visual acuity is not as sharp. *Horizontal cells* transmit *inhibitory* signals to the bipolar cells, which enhance the contrast between areas of the retina that are strongly stimulated and adjacent areas that are more weakly stimulated. Lastly, ganglion cell axons that form the optic nerve carry the information to the brain for processing.

The Function of the Retinal Pigment Epithelium

As noted, vision depends upon the isomerization of 11-*cis*-retinal to 11-*trans*-retinal. Each light photon striking a photoreceptor isomerizes retinal, and billions of photons can strike the retina at any one second. The 11-*cis*-retinal must be regularly replaced to maintain the cycle, a task for which the *retinal pigment epithelium* (RPE) is critical. RPE is a single cell layer thick, consisting of relatively uniform cells whose apical end is covered with dense microvilli. RPE cells are polygonally shaped and contain apical microvilli and basal membrane enfoldings. Their tight junction cell connections help to seal the vitreous humor in the eyeball and contribute to the blood-retina barrier. Posterior to the RPE is the vascular choroid layer, and posterior to that is the connective tissue known as the sclera.

Research on the eyes of different species has found that, although major differences among them exist, the retinal pigment epithelium shows "little variation."

RPE touches the extremities of the photoreceptors, both the rods and the cones, and the microvilli interdigitate with their sides.[32] The interphotoreceptor matrix contains soluble and insoluble components which are critical to the photoreceptor/RPE functions. Seemingly simple in appearance, the RPE has "a complex structural and functional polarity that allows them to perform highly specialized roles."[33] One of their major functions is to collect the used retinal from the photoreceptors. They then use vitamin A to regenerate the retinal, after which it is transferred back to the photoreceptors.[34] Vitamin A regeneration requires the RPE to manufacture retinol isomerase and other compounds. The RPE also stores large quantities of vitamin A.

Research on the eyes of different species has found that, although major differences among them exist, the RPE shows "little variation."[35] The small variations that exist in the RPE are due to differences in the retina structure, indicating its critical role in the vision of all vertebrates. One study found retinol isomerase existed in all the major vertebrates tested and was lacking in all three cephalopods tested.[36] Bridges concluded that reciprocal flow of retinoids between the retina and the site of isomerase action in the RPE is a feature common to the visual cycle in all vertebrates.[37] Since RPE cells use much energy and nutrients, they must be in intimate contact with *both* the photoreceptors and the blood supply, in this case the choroid, to carry out this critical function.[38]

Phagocytic Role of the Retinal Pigment Epithelium

Another role of the RPE is to recycle the used rod and cone outer segment membranes, the portion closest to the RPE. This area is often referred to as the business end of the photoreceptor cells, because it is here where the membranous disks that respond to light are located. Cones usually contain from 1,000 to 1,200 disks, and rods from 700 to 1,000. The high level of outer segment activity requires them to be continually replaced.[39] New outer segment membranes continually grow at the outer photoreceptor segment base, adding to the photoreceptor length.

Photoreceptor outer segments are renewed at "an astonishingly rapid pace."[40] A normal rod photoreceptor sheds about 10% of its outer segment disks at its apex and renews the same amount daily.[41] As the outer segment lengthens from its base, the oldest membrane, which is the distal end, is shed in segments of one to three disks at a time. Those sloughed off are phagocytized by the RPE in order to recycle its parts.[42] This process is continuous, effectively maintaining the high sensitivity of the photoreceptors.[43] A summary of this cycle by Bok and Young is as follows:

> ... the retinal pigment epithelium carries out several functions that are crucial for the normal operation of the visual system. One of these important roles, appreciated for about a decade, is the phagocytosis of rod outer segment debris. This scavenging activity goes on daily at an impressive rate in the normal retina. It can be accelerated to extraordinary levels when outer segments are damaged. Disruption of this phagocytic function may underlie a variety of clinical disorders, some of which result in blindness.[44]

RPE microvilli interdigitate and surround the photoreceptor outer segments to effectively carry out their phagocytic and recycling role. The first step in phagocytosis is *recognition* (causing their binding to the RPE apical microvilli) followed by *invagination* and, lastly, ingestion by phagosomes. Pseudopods that engulf the rod and cone outer receptor fragments are controlled by actin in much the same way that single-celled animals, such as the amoeba, use pseudopods to consume food. The RPE then breaks down the ingested material by enzymes stored in its lysosomes. Lastly, the free radicals and superoxides produced by enzyme action in the RPE must be neutralized by superoxide dismutase, peroxidase, and other enzymes.[45]

Nutrient Role of the Retinal Pigment Epithelium

The RPE selectively transports nutrients from choroidal circulation to both the photoreceptors and retinal cells. The RPE cell-tight junctions prevent diffusion of even small molecules into the vitreous humor and insures that the metabolites required by the outer retina can move to where they are needed.[46] The RPE has a function like that of a placenta to insure that the outer retina is protected from injurious compounds and yet allows the necessary nutrients to pass into the area of the rods and cones. To insure that enough of the needed nutrients pass the RPE barrier, the basal membrane is highly enfolded to produce more surface area. This role is critical because the rods and cones require a greater blood supply than any other bodily tissue.[47] Which compounds pass though are determined by basal membrane receptors. RPE also synthesizes and secretes extracellular matrix molecules.

Processing Visual Information

The potential interference of light as it traverses several layers of retina before reaching the photoreceptors in an inverted eye is overcome by visual processing. When *bipolar* or *amacrine* cells transmit excitatory signals to ganglion cells, the ganglion cells become depolarized, initiating a nerve impulse. Nerve impulses travel along axons of the *optic (II)* cranial nerve, leading to the *optic chiasm* where some fibers cross over to the opposite side and some remain on the same side (chiasma means *cross* as shown by the letter X). On the other side of the optic chiasm, the fibers are named the *optic tract* and synapse with neurons in the *lateral geniculate nucleus* of the thalamus. The lateral geniculate nucleus neurons then form a passageway called the *optic radiations* to carry the information for processing to the *primary visual areas* in the occipital lobes of the cerebral cortex.

Each eye sees a slightly different visual field, and the large *overlapping* area is called the binocular visual field used to produce stereo vision. One eye will see a crescent-shaped peripheral monocular visual field that the other eye cannot see, and the same will occur on the opposite side with the opposite eye. Also, each eye has a blind spot caused by a hole in the retina where the optic nerve must pass through in order to travel to the brain. This blind spot falls on a different place in each retina, and the information from both eyes is *combined* so that these visual blind spots are not normally perceived.

The potential interference of light as it traverses several layers of retina before reaching the photoreceptors in an inverted eye is overcome by visual processing.

Light rays from an object in the temporal half of the visual field (that facing *away* from the nose) will fall in the nasal half of the retina, and conversely light rays from an object in the nasal half of the visual field will fall on the temporal half of the retina, reversing the image as occurs when a transparent slide is projected by a slide projector. Also, light rays at the *top* of the visual field strike the *inferior* portion of the retina, and those at the *bottom* of the visual field are projected on the *superior* portion of the retina, again reversing the image. Both the left-right and up-down reversal must be corrected by the brain.

Information received by the brain must be extensively processed in other ways as well. This complex operation involves at least three separate systems located in the cerebral cortex, each with a specific function. One system processes information related to *shape*, another regarding *color*, and a third about *movement*, *location*, and *spatial* organization of the object. Goldsmith concluded that the optical design of the vertebrate eye "approaches optima predicted from physics" and that in the real world:

> animals have a way of confounding the assumptions and boundary conditions in hypothesized models of optimal behavior. In dealing with the interrelated sensory tasks of maximizing spatial acuity and contrast sensitivity, however, both the "camera" eyes of Old World primates and birds, as well as the com-

> pound eyes of diurnal insects, present clear examples of evolutionary optimization ... The investigator's task in examining the hypothesis of optimization is therefore to ask how closely the optical performance of eyes of different optical design approaches the limits set by physics ... Despite the very different modes of design that underlie the construction of the single-lens eyes of vertebrates and the compound eyes of arthropods, similar considerations determine their capacities to resolve images.[48]

The Macula

An area of the retina in the central macula called the *central fovea* is part of the solution to the problem of light loss due to the reversed retina. The nerve cell bodies in this area are displaced sideways to provide a clearer path for light to reach the photoreceptor cells.[49] The macula area is no larger than pencil lead in diameter but is about 100 times more sensitive to small features than the rest of the retina. Vision is the sharpest at the macula, which is critical in providing the brain with information needed to construct an image. It allows us to read, watch television, recognize friends, and even walk. Most of the rest of the retina actually is concerned with peripheral vision. The macula provides information needed to maximize image detail, and the information obtained by the peripheral areas of the retina helps to provide both spatial and contextual information.

The peripheral retina also functions to survey a large visual area for clues to determine where a person should focus his or her macula for more input. The peripheral area does not need to pick up much detail because its role is primarily to inform the brain of locations that may need more informational input. This structure allows the person to be aware of a wide visual field, yet at the same time not be distracted by it.

An area of the retina in the central macula called the central fovea is part of the solution to the problem of light loss due to the reversed retina.

If the entire retina were sensitive to the same level of detail as the macula, the brain would suffer from sensory overload and not function properly. The sensory overload problem is well understood from research on hyperactivity and auditory sensory overload. If the retina were reversed so that the rods and cones faced in the direction of the light, the peripheral area may require a means of *lowering* the light intensity.

The importance of the RPE is indicated by the fact that one of the most common causes of blindness in the developed world, macular degeneration, is a result of RPE deterioration.[50] In this disease, the eye's macula loses its ability to function, causing major central vision loss. In macular degeneration, not only does the central vision deteriorate but the patient is less able to focus on an object of interest. The retinal pigment cells do not replace themselves by cell division as do most cells. Consequently, when they are damaged, the retina cells also soon die. Demise of the RPE is often caused by intracellular accumulation of excessive levels of lipofuscin damaged so severely that the cell's native enzymes cannot properly degrade them.[51] *Central serous retinopathy* is also considered to be a RPE disorder, specifically its ion pump function, and/or a result of choroidal vascular hyperpermeability.

Detached Retina and the Role of Pigment Epithelial Cells

The retina is evidently held to the RPE largely by the interphotoreceptor matrix. When the retina pulls away from the pigment epithelium at the interphotoreceptor matrix area, *a detached retina* results. Fluid that accumulates between the neuron portion of the retina and the pigment epithelium gradually forces the thin pliable retina to billow out toward the lens of the eye. Some results of this change are visual field defects, light flashes, floaters, and distorted vision caused by optical effects resulting from the new position of the retina in relationship to the lens.[52]

Detachment of the retina from the pigment epithelium also causes a drastic reduction in the rhodopsin regeneration rate. As a result, when the pigment epithelium can no longer function to regenerate the rods and cones, vision is distorted. Eventually the death of significant amounts of retina tissue occurs in those areas that have become detached from the RPE. The retinal detachment can sometimes be halted by migrating pigment epithelium cells that bond to the separating retina, preventing its progressive separation. When this occurs a scar is formed on the retina called a pigmentation line. If this system fails, the progressive detachment can often be halted by laser therapy, a procedure only minimally invasive, because laser light is able to pass through the cornea and the lens without damaging them. Laser therapy stimulates the mi-

gration of the pigment epithelium cells, inducing the pigmentation line.

Functions of the Pigment

The pigment epithelium sheet consists of epithelial cells that produce organelles containing melanin granules. Since RPE cells are located between the choroid and the retina, they often are classified as part of the choroid instead of the retina. The melanin they contain functions to absorb stray light, preventing the reflection and scattering of light within the eyeball, and ensuring that the image cast on the retina by the cornea and lens remains sharp and clear.

Another function of the pigment is to form an opaque screen behind the optical path of the photoreceptors. This light absorptive property of the pigment is critical to maintaining high visual acuity. Hewitt and Adler concluded that the diverse function of the retinal pigment epithelium cells "is essential for the normal functioning of the outer retina."[53] For this reason, normal retinal function requires that the RPE and photoreceptors be in close proximity. A summary of the role of the RPE is as follows:

> The rods and cones are constantly replacing the visual pigment disks. The old ones are discarded toward the outside, where the pigment epithelium cells absorb them. Were the disks to be disposed of toward the incoming light, we would soon expect a murky situation inside the eye. The rods and cones take no vacation, the disks are constantly being replaced throughout our lifetime ... The reason for renewal of the disks in the eye ... [includes] preventive maintenance and a way of providing a fresh supply of visually sensitive chemicals. It appears that the disks [are] ... absorbed at the end of the rods.[54]

Tapetum Lucidus

Many animals contain a structure called a *tapetum lucidus* in addition to the pigmented epithelium. The layer called the tapetum effectively reflects the incoming light back to the rods, giving them a second opportunity to absorb light, thus providing much greater visual acuity in low light levels.[55] The tapetum produces the reflective eyes characteristic of nocturnal animals.[56] This structure gives cat, dog, and deep-sea or turbid-water fish eyes the distinctive glow at night called *eyeshine*, which causes them to appear to be lit up. Excellent night vision allows predators to prowl at night when competition for food and space is less. A cat's night vision is estimated to be six times better than humans. Their eyes are so effective that they can operate in light that humans perceive as close to pitch black. The tapetum's importance is indicated by the fact that the part of the pigment epithelium which covers the tapetum is "always devoid of pigment so that there is no interference with the back reflection of the light."[57]

This structure allows a cat to see much better in dim light but at a cost of much poorer resolution and less visual clarity during daylight.[58] The cat has more rods than cones compared to humans; consequently, it is more sensitive to low light, but has much *less* resolving power and an inferior ability to detect colors compared to humans. Animals with a tapetum usually have poor vision during daylight hours and many possess highly contractile pupils to protect their retina.[59]

The Retina Pigmented Epithelium's Role in Development

Pigmented epithelium is also critical for normal vertebrate eye development. Raymond and Jackson conclude from their study:

> ... a series of reciprocal cellular interactions that determine the fate of the eye components ... [exists during development and the] presence of the RPE is required for the normal development of the eye *in vivo*. Its presence early in development is necessary for the correct morphogenesis of the neural retina. After the neural retina has started to differentiate, the RPE is still necessary, either directly or indirectly, to maintain the organization of the retinal lamina.[60]

The RPE actually plays a succession of roles during embryonic development, including trophic influence, transport functions, retinomotor response, and phagocytic and inductive interaction.[61]

Other Possible Designs

If the human retina were verted, we have no evidence that vision would be better. Most likely it would be worse. Comparisons of different eyes are difficult to make because, although the quality of the image projected on the retina can be evaluated by a study of the lens system's optical traits, we lack direct knowledge about the actual image produced in the brain.

A major concern, when critiquing the existing vertebrate retina design, involves speculations on the quality of vision that would result from another design. If the retina were reversed, the RPE or its analog and its cellular support system would have to be placed either in *front* of the photoreceptors or on

their side. These approaches are clearly inferior to the existing vertebrate system that produces superior sight for terrestrial animals. If located in front of the retina, depending on how transparent those cells were, this design could prevent most light from reaching the photoreceptors.

If the RPE were located on each side of the rods and cones, as in the cephalopods, primarily only the front of the sensory cells would be able to respond to light. Prince even claims the cephalopods side design "is protective and shields the receptors from excess light."[62] Opaque wastes would accumulate in the path of light, and nutrients would have to be plentiful, thereby further diminishing the amount of light reaching the photoreceptors. Surrounding each photoreceptor RPE retina cell also requires increasing the space between the photoreceptors, further decreasing the amount of light able to strike the photoreceptors, consequently lowering vision resolution. Recycling of the outer segments so photoreceptors can be quickly regenerated would also be a problem, if the photoreceptors faced the vision light path line. If the eye were designed according to the Darwinist plan, the following would be the result:

> Should the disk end of the rods and cones be reversed in direction so as to face the light, as some evolutionists suggest they should, we would probably have a visual disaster. What would perform the essential function of absorbing the some 10,000 million disks produced each day in each of our eyes? They would probably accumulate in the vitreous humor region and soon interfere with light en route to the retina. If the pigment epithelium layer were placed on the inside of the retina so as to absorb the disks, it would also interfere with light trying to reach the rods and cones. Furthermore, the pigment epithelium, which is closely associated with the disk ends of the rods and cones, also provides them with nutrients for making new disks. The epithelium gets its nutrients from the rich blood supply in the choroid layer next to it. In order for the pigment epithelium to function properly, it needs this blood supply. To put both the pigment epithelium and its choroid blood supply on the inside of the eye, between the light source and the light-sensitive rods and cones, would severely disrupt the visual process.[63]

The sensitivity of the existing human inverted design is so great that only one photon is able to elicit an electrical response.[64] Consequently, functional sensitivity of the verted retina could not be significantly improved. Ferl and Wallace note:

> Neurobiologists have yet to determine how such a negative system of operation might be adaptive, but they marvel over the acute sensitivity possible in rod cells. Apparently rod cells are excellent amplifiers. A single photon (unit of light) can produce a detectable electrical signal in the retina, and the human brain can actually "see" a cluster of five photons—a small point of light, indeed.[65]

Greater sensitivity of the inverted retina, if this were possible, may result in poorer vision due to sensory overload. Williams syndrome patients have hearing so superior to that of normal persons that they can hear a faint whisper. Unfortunately, this causes them serious problems dealing with loud noises; thunder is actually physically painful.

If the human retina were verted, we have no evidence that vision would be better. Most likely it would be worse.

Though higher visual acuity may improve night vision, it would surely result in difficultly seeing during daylight hours.[66] This would not be functional for most people who must work in a normal human environment. Actually, a case can be made that *more* light blockage of the retina would be functional. Many people must wear sunglasses because the outdoor light is too bright. In a review of the literature, Young found that excess light is now a serious health problem. He notes:

> All of the major cellular and molecular features of age-related cataract have been reproduced in the laboratory ... solar radiation can with similar cogency explain the distinctive global pattern of age-related cataract among human populations—the risk of cataract depends on where one lives on the surface of the earth ... When cataract blindness statistics from 55 different countries of the world are grouped according to latitude, it is found that in the tropics there is a fivefold increase in blindness resulting from cataract than at northern latitudes, whereas intermediate latitudes fall in between. Although many factors are involved, sunlight is the only one known to vary in a gradient from high in the tropics to low in the northern latitudes ... Current evidence provides the basis for the design of protective lenses that minimize the hazards of sunlight exposure without significantly interfering with vision. The prescription has two components—one to protect the lens, the other to protect the retina ... Use of sunglasses ... should begin early in childhood and be continued throughout the life span whenever exposure to bright sunlight is desirable or necessary. Radiation damage to delicate ocular structures can occur at any age and tends to be cumulative. Even modestly effective preventive measures may produce highly significant benefits if applied over an extended period.[67]

Albinos lack pigment in their pigment epithelium cells, and consequently they often suffer from foveal hypoplasia. As a result, they lack the detailed central vision. They also lack iris pigment and must wear sunglasses because even moderately bright light may severely adversely affect their vision.[68] Even blue-eyed people are at a disadvantage because the blue pigment allows more light in than darker iris colors. Consequently, blue-eyed people suffer from more vision problems and blindness.[69] Being able to effectively read with very dim light may be an improvement in some situations, but since most human activities occur during daylight hours, and darkness is functional to induce sleep due to pineal gland activity, the existing secretion system appears to be the most effective.

Furthermore, although the light yellow tint of the eye lens filters out some ultraviolet light, the inverted eye design serves to filter out much of the remaining ultraviolet light. The incoming light must pass through the overlying neural components and blood vessels and the penetrating power of ultraviolet light is markedly inferior to white light.[70] The verted eye is used in animals, such as the octopus, that live under water where most of the ultraviolet light is filtered out. Consequently, they have less need for this protection.

Given the role of the pigmented epithelium, it is clear that the existing design is an ideal compromise. The main question is: "Is the retina reversal an obstacle to vision?" Williams notes that the vertebrate eye works quite effectively despite the retina reversal because it is a precise visual instrument designed to function with the rods and cones facing away from the light. He explains:

> The tissues intervening between the transparent humors of the eye cavity and the optically sensitive layer are microscopically thin. The absorption and scatter of light is ordinarily minor, and functional impairment seldom serious ... Red blood cells are poor transmitters of light, but when moving single file through capillaries can cause only a negligible shading of the light sensors. In larger venuoles and arterioles they cast dense shadows and blot out images. That we do not ordinarily perceive these shadows is the result of minute involuntary eye movements, which keep the blood-vessel shadows moving, and of our brains recording the flux of images as continuous pictures. The reality of the shadow of the *vascular tree* ... can be demonstrated with a flashlight and instructions from a visual physiologist.[71]

Nerve cell fibers and the small branches of the central retina artery and vein actually produce minimal hindrance to light reaching the photoreceptors. Most cells are 60 to 70 percent water and thus are largely transparent. In contrast to most peripheral nerves, nerve fibers in front of the retina are not mylinated. Myelin, an opaque, whitish lipid that coats the nerves, would block much light. These facts have forced Dawkins to note:

> With one exception, all the eyes I have so far illustrated have had their photocells in front of the nerves connecting them to the brain. This is the obvious way to do it, but it is not universal. The flatworm ... keeps its photocells apparently on the wrong side of their connecting nerves. So does our own vertebrate eye. The photocells point backwards, away from the light. This is not as silly as it sounds. Since they are very tiny and transparent, it doesn't much matter which way they point: most photons will go straight through and then run the gauntlet of pigment-laden baffles waiting to catch them.[72]

Moving shadows produced by the venules and arterioles are also highly functional because they produce momentary darkness to aid in the rod and cone regeneration. Constant bright light would excessively bleach the photopigment, and lower light achieved by the existing design allows their regeneration. Further, as noted above, the RPE metabolic machinery is "essential for the normal functioning of the outer retina [and] because of the nature of these interactions, it is essential that the RPE and photoreceptors be in close proximity" for normal retina function.[73]

Given the role of the pigmented epithelium, it is clear that the existing design is an ideal compromise.

The inverted eye also produces the most acute image of all known designs. The eyes of birds not only produce the sharpest vision of all known animals, but they can form sharp images on all areas of their inverted retina. In addition, they have two to five times the number of cones per square millimeter as do humans.[74] Birds also rely on a large structure that protrudes into the retina called a *pectin,* which most likely replaces the embedded blood vessels in mammals. This system evidently interferes less with vision than would a network of blood vessels, and is another reason why birds have unusually high visual activity.[75] Many reptiles have a structure similar to the pectin called a *conus papillaris,* which is not pleated, is more cone-like, and often differs in other ways from the pectin structure.[76]

Birds are also sensitive to light in the near ultraviolet spectrum, and have red oil droplets in the *lower* part of their eyeball cavity that enhances the contrast of objects, such as animals in a green foliage background. Furthermore, their eyeball contains yellow droplets in the *upper* area of the eyeball that enhances objects seen against the sky by filtering out much of the blue background. The two different oils are kept separate by density differences. These modifications help animals to see in their world but would be a major hindrance to humans in our terrestrial world.

Conclusions

Claims of poor retina design are often raised by evolutionists to argue against Intelligent Design.[77] A review of research on the vertebrate retina indicates that for vertebrates the existing inverted design is superior to the verted design, even the system used by the most advanced cephalopods. Its design has been maximized for life in our environment and no doubt would function poorly in another environment, such as that experienced by undersea bottom dwellers. This review supports Hamilton's conclusion:

> Instead of being a great disadvantage, or a "curse" or being incorrectly constructed, the inverted retina is a tremendous advance in function and design compared with the simple and less complicated verted arrangement. One problem amongst many, for evolutionists, is to explain how this abrupt major retinal transformation from the verted type in invertebrates to the inverted vertebrate model came about as nothing in paleontology offers any support.[78]

Rather than being fired, our camera designer would no doubt be promoted for utilizing a less obvious, but, as a whole, a far more functional design. ✠

Acknowledgments

I wish to thank Dr. Tara Richmond O.D. for her comments on an earlier draft of this manuscript.

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The Garden of Eden: A Modern Landscape

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In this paper, I try to apply the findings of modern geology to Gen. 2:10-14. I deduce from the evidence that the four rivers of Eden – the Pishon, the Gihon, the Hiddekel, and the Euphrates – were real rivers which existed on a modern landscape before Noah's flood. The now-dry Wadi al Batin was probably the Pishon River, the Gihon was probably the Karun River, and the Hiddekel (Tigris) and Euphrates Rivers flowed in approximately the same courses as they occupy today. The confluence of these four rivers was located at the head of the Persian Gulf, but a Gulf that may have been inland from where it is today. The spring which "rises up" in Eden could have been supplied by the Dammam Formation, the principal aquifer of the region. Oil-drilling in southern Iraq confirms that six miles of sedimentary rock exist below the biblical site for the Garden of Eden. This same sedimentary rock is the source of bitumen at Hit, a site which may have supplied Noah with pitch for constructing the ark. The question is asked: How could pre-flood Eden have been located over six miles of sedimentary rock supposedly formed during Noah's flood?

While the secular world almost universally assumes that the story of Adam and Eve in the Garden of Eden is legend, many evangelical Christians believe it to be a true story – that Adam and Eve were historical people and that the Garden of Eden was a historical place. One reason for this belief is because the Bible gives its geographic location: two of the names of the four rivers mentioned in Gen. 2:10–14 have been preserved from biblical times. According to the Bible, the Garden of Eden was located somewhere in southern Iraq where the Euphrates and Hiddekel (Tigris) Rivers flowed into the head of the Persian Gulf – that is, they flowed on a modern landscape that is still recognizable today.

What most Christians do not realize is that this biblical identification of Eden on a modern landscape is in direct conflict with Flood Geology, a premise promoted by Creation Science. The basic tenet of Flood Geology is that all (or almost all) of the sedimentary rock on the planet earth was formed during Noah's flood. But modern geologic study has shown (by oil drilling) that the landscape of southern Iraq is underlain by six miles of sedimentary rock. Thus the question can be asked: How could the Garden of Eden, which existed on a pre-flood landscape existing *before* the flood, have been located *over* six miles of sedimentary rock created *during* the flood?

This paper is organized accordingly. First, I discuss in detail the four rivers of Eden and the geographic features connected with those rivers in order to demonstrate:

1. All four rivers were historical rivers, not mythical rivers made up in the mind of the Genesis writer.

2. All four rivers flowed into the Persian Gulf in the land of Mesopotamia. They were not rivers that flowed in other parts of the world as has been suggested by various authors.

3. All four rivers (or now-dry riverbeds) of Genesis are *still there*; that is, the Genesis writer identified a modern landscape, one which is almost identical to that which still exists in the Iraq-Arabia-Iran area today.

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Second, I try to identify the most likely place for the Garden of Eden based on its biblical location at the confluence of these four real rivers. I present evidence from modern geology that this confluence in ~4000 B.C. may have been at a Persian Gulf located inland from where it is today.

Third, I discuss why the Garden of Eden being located on a modern landscape is in direct conflict with Flood Geology. I conclude that the Bible never claims that all of the sedimentary rock on earth was formed during Noah's flood.

The ideas in this paper are based mainly on the geological, archaeological, and theological literature. However, two new ideas never before proposed (to the author's knowledge) are presented herein: (1) the "onyx stone" of Gen. 2:12 may have been mined from the Wadi al Aqiq area in central Arabia, and (2) the river which went out of Eden (Gen. 2:10) may have been a spring supplied by the Dammam Formation, the principal aquifer for the region.

"And a river went out of Eden to water the garden; and from thence it was parted, and became four heads.

"The name of the first is Pishon; that is it which compasseth the whole land of Havilah, where there is gold;

"And the gold of that land is good: there is bdellium and the onyx stone.

"And the name of the second river is Gihon; the same is it that compasseth the whole land of Cush.

"And the name of the third river is Hiddekel; that is it which goeth toward the east of Assyria. And the fourth river is Euphrates" (Gen. 2:10–14).

The Name of the First is Pishon

The Land of Havilah

The Bible mentions two Havilahs in the Table of Nations: Havilah the son of Cush (Gen. 10:7) and Havilah the son of Joktan (Gen. 10:29). The "land of Havilah" has been interpreted by many biblical scholars[1] to be Arabia, and Joktan is considered to be the head of the tribes of Arabia, as most of his sons can be traced to places and districts within what is now Saudi Arabia and Yemen. Apparently the "land of Havilah" referred to a whole region rather than one particular place, since there appears to have been more than one tribe by that name.[2]

But where is the Pishon River within the land of Havilah? There is no river flowing from the western mountains of Saudi Arabia down to the head of the Persian Gulf. There is no perennial river flowing across Saudi Arabia today, but there is evidence that such a river did flow there sometime in the past. Only four inches of rain a year now fall in Saudi Arabia, but during the periods from about 30,000 to 20,000 years B.P. (before present) and from about 10,000 to 6000 years B.P., the climate was much wetter than it is today.[3] Even as late as 3500 B.C. (before Christ), ancient lakes are known to have existed in the "Empty Quarter" of Saudi Arabia, which is today the largest sand desert in the world (Fig. 1). A somewhat drier but still moist phase existed from about 4000 to 2350 B.C., followed by a more arid phase from about 2350 to 2000 B.C. It was then, at about 2000 B.C., that the climate turned hyper-arid and the rivers of Arabia dried up.

Has the Pishon River Been Found?

In his article, "The River Runs Dry," James Sauer describes how satellite images have detected an underground riverbed along the Wadi al Batin (wadi means the same thing as arroyo, a dry riverbed).[4] Sauer identified this river as the Pishon River of the Bible, a river which flowed at a time when the climate was wetter than it is today.

The Wadi al Batin/Wadi Rimah system drains some 43,400 square miles of Saudi Arabia and Kuwait. The now dry Wadi al Batin enters the Persian Gulf at Umm Qasr in Kuwait (Fig. 1), but in the past the Pishon entered the Gulf north of Umm Qasr, in the Euphrates-Tigris river basin. The evidence for this is a triangular, fan-shaped, delta plain of cob-

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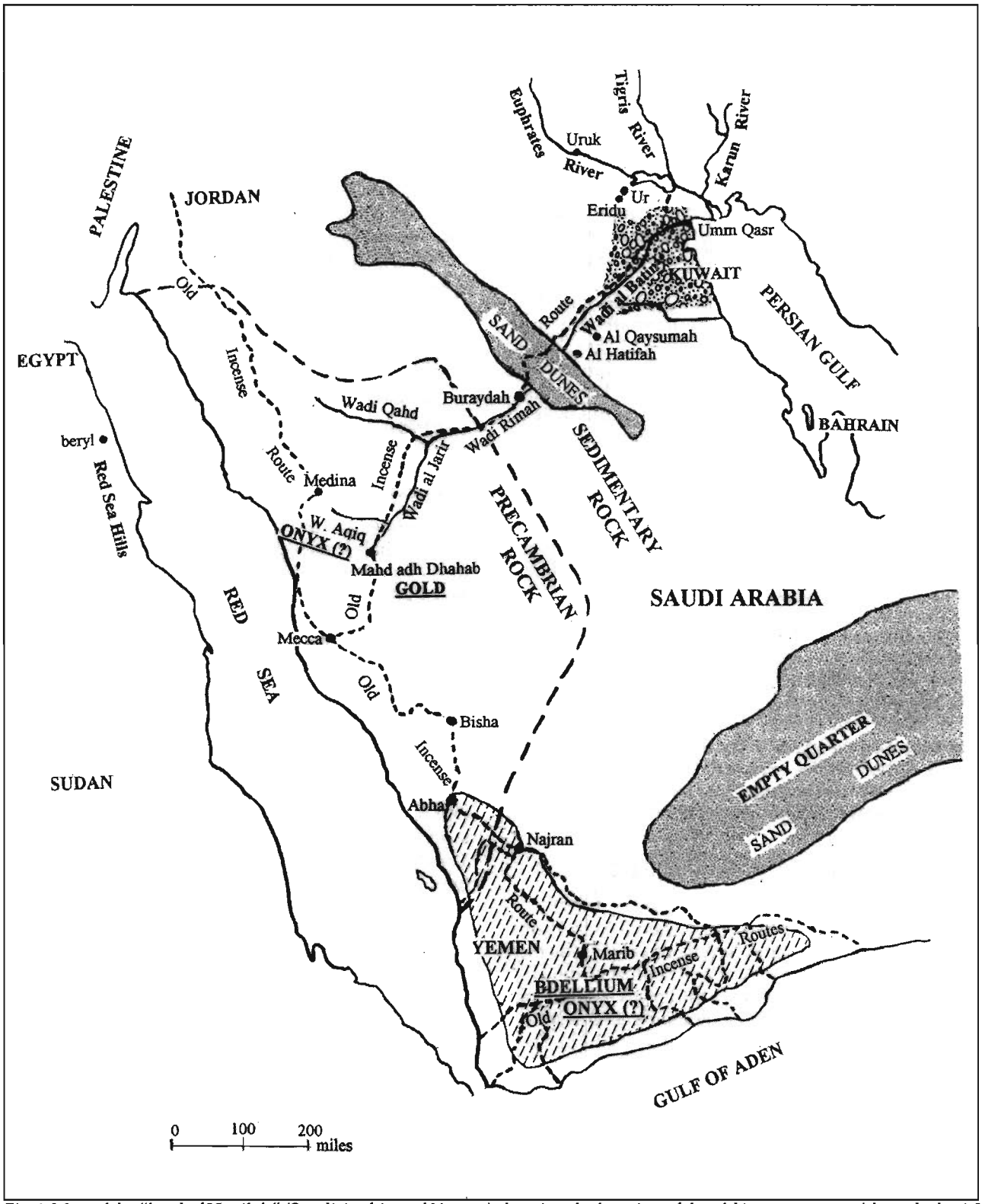

Fig. 1. Map of the "land of Havilah" (Saudi Arabia and Yemen) showing the location of the old incense routes (short dashes);[5] the area where bdellium was grown (diagonal hatching);[6] Precambrian and sedimentary rock (long dashes between the two areas);[7] the gravel fan deposited by the Pishon River (gravel symbol);[8] and other places mentioned in the text.

bles and pebbles in the Dibdibah area, which has its apex near Al Qaysumah and which extends northward toward the Euphrates (Fig. 1).[9] The cobbles and pebbles of this gravel plain are composed of crystalline rock that is characteristic of the western mountains of Saudi Arabia, and they decrease in size as they approach the Gulf area. The geological implication of this is that the source of the cobbles was to the southwest in Saudi Arabia, and that enough water once flowed in the Pishon River to transport rock debris from the Western highlands down toward the Euphrates-Tigris river basin.

From the Persian Gulf at Umm Qasr, the now dry Wadi al Batin can be followed to the southwest, upstream past the borders of Kuwait, and into Saudi Arabia, where it is incised into a Tertiary limestone-sandstone sedimentary rock terrain.[10] Then, just past Al Hatifah, the dry riverbed is engulfed by immense sand dunes and disappears (Fig. 1).

This is where the satellite photos come in. These photos indicate that the Wadi al Batin continues to the southwest, beneath the sand, and emerges as the Wadi Rimah (that is, both wadis were part of the same river system in the past, before being covered by sand dunes). About eighty miles further in the upstream direction, the Wadi Rimah bifurcates into the Wadi Qahd on the northwest, and the Wadi al Jarir on the southwest (Fig. 1). The Wadi al Jarir continues up gradient to the area of the Mahd adh Dhahab gold mine exactly as the Bible says: *"The River Pishon encompasses the whole land of Havilah, where there is gold"* (Gen. 2:11). Sauer remarked in his article: "This implies extraordinary memory on the part of the biblical authors, since the river dried up between about 3500 and 2000 B.C."[11]

Mahd adh Dhahab: Cradle of Gold

"And the gold of that land is good" (Gen. 2:12).

The gold of that land is indeed good! Mahd adh Dhahab (literally meaning "cradle of gold") was the largest and one of the richest gold mines of the ancient world. It is believed to be the fabled "Ophir" of the Bible, the source of King Solomon's gold. (Ophir was another one of Joktan's sons; Gen. 10:29.) The gold of Ophir is referred to in the following passages: 1 Kings 9:28, 10:11, 22:48; 1 Chron. 29:4; 2 Chron. 8:18, 9:10; Job 22:24; Ps. 45:9; and Isa. 13:12. Based on the number of ancient mine tailings (refuse left over after the ore is treated), geologists have estimated that the Mahd adh Dhahab mine produced more than 950,000 ounces (about 30 metric tons) of gold in antiquity.[12] Also, based on radiocarbon ages, they believe it was mined during the reign of King Solomon (961–922 B.C.) and during the Abbasid Caliphate (750–1258 A.D.).[13] It has also been mined in modern times.

Assuming that Mahd adh Dhahab is the legendary King Solomon's mine, was it also the source of the "good gold" of Gen. 2:12? After all, Gen. 2:12 refers to a time much older than that of Solomon. There is no way of knowing for certain, but three lines of evidence suggest that gold may have been mined at Mahd adh Dhahab much earlier than during Solomon's time—even as early as the patriarchal period or before.

... gold may have been mined at Mahd adh Dhahab much earlier than during Solomon's time—even as early as the patriarchal period or before.

The first line of evidence comes from the Mahd adh Dhahab itself. A trenching program carried on in 1973 showed that the richest ground remaining at Mahd adh Dhahab lies southeast of Mine Hill in several ancient channels on the flanks of Jebel Mahd adh Dhahab and in valleys that drain the jebel (jebel means mountain).[14] These ancient erosion channels could have produced surficial placer and alluvial gold deposits that could have been collected by pre-Solomonic people. This method of collection would have left little or no trace of early mining activity.

The second line of evidence is the reference to Ophir in Job 22:24: *"Then shalt thou lay up gold as dust, and the gold of Ophir as the stones of the brooks."* The date that the Book of Job was written is uncertain, but some biblical scholars place Job in the patriarchal period, as inferred from his genealogy (Job lived about the same time as Abraham), his stated great age, and the absence of the mention of the law and the Tabernacle or Temple in this book.

The third line of evidence is archaeological. Gold suddenly appears in the archaeological record of Mesopotamia in the Uruk Period (about 3500 B.C.). (For a chart of the archaeological periods of Mesopotamia, refer to Table 1.) A small variety of gold artifacts have been recovered in southern Iraq that date to about 3500 B.C.; for example, in Uruk those found in the layers underlying the White Temple.[15] However, by the Early Dynastic III Period (about 2500 B.C.), the use of gold, electrum (a mixture of 60–70% gold and 30–40% silver), silver, and copper had increased significantly, as evidenced by the

Royal Tombs of Ur where these metals have been found in great profusion.[16]

Where did these ancient Mesopotamian peoples get all of the gold and silver that they used for their jewelry and temples? They must have had established trade relations with places where these metals were being mined, since Mesopotamia itself is devoid of metal deposits. The nearest gold-silver mine to Ur and Uruk is Mahd adh Dhahab (Fig. 1).

Gold occurs at Mahd adh Dhahab mostly as electrum (gold-silver) within quartz veins. Besides gold, the mines have also produced a substantial amount of silver, copper, zinc, and lead. The quartz veins containing the gold intrude (cross-cut, or are younger than) the Mahd adh Dhahab Series of Precambrian volcanic and sedimentary rocks.[17] The quartz of the veins is typically banded and shows a cockscomb-like structure of zoned quartz crystals. Chalcedony and chert are commonly associated with the quartz veins, chert being banded and variously colored (red, white, green, gray, and brown).

The Onyx Stone

The "onyx stone" of Gen. 2:12 is not as easy to place. The problem is two-fold. The first is archaeological. The early periods of gold mining at Mahd adh Dhahab have not been adequately investigated; even less has there been a search for the source of precious stones known to have been traded in antiquity. Some biblical passages confirm that precious stones were being brought from Arabia to Israel along with gold and incense. "Precious stones" are mentioned with the gold of Ophir in 1 Kings 10:2, 10, 11 and 2 Chron. 9:1, 10. The question is, "What were considered to be precious stones in antiquity?" An answer is offered by 1 Chron. 29:2: "*... onyx stones, and stones to be set, glistening stones, and of various colors, and all manner of precious stones, and marble stones in abundance.*" This passage shows that onyx was considered to be precious, although we now consider such stones to be only semiprecious.

The second problem with identifying the "onyx stone" of Gen. 2:12 is linguistic. What exactly was meant by the term "onyx" to the writer of Genesis? In antiquity, many different names were used for stones, even for the same type of stone, depending on color, quality, and appearance.[18] Also in a number of instances, it is apparent that the meaning of these names has changed with time. The Greek word "*onychion*" (onyx) employed as a general term could refer to carnelian, beryl, lapis lazuli, rock-crystal quartz, or even marble, but usually it was used for the banded and variegated subvarieties of chalcedony (agate, onyx, sardonyx). While there is no positive, absolute guide to the proper translation of the word "onyx," a number of possibilities can be reasonably ruled out.

Marble. Marble is metamorphized limestone. While marble is banded like onyx, and while some marble rock does exist in Saudi Arabia, marble is probably not what the Bible is referring to in Gen. 2:12. For one thing, in 1 Chron. 29:2 "marble stone" is mentioned separately from "onyx stone" suggesting that, in the ancient mind, these were two different types of substances. In antiquity, the word "onyx" was usually reserved for very hard silica substances used in jewelry, while "marble" was reserved for calcium carbonate, a softer substance used as a building material.

Lapis lazuli. Lapis lazuli is the mineral lazurite, a commodity which was traded extensively in ancient times throughout Mesopotamia and which was used in the manufacture of jewelry and other items. The source and trade routes of this mineral have been well documented, the agreed-upon source area being the Badakhshan region of Afghanistan.[19] Since lapis lazuli does not occur on the Arabian Peninsula, this mineral can also be ruled out as the onyx stone of Gen. 2:12.

Beryl. Beryl is a beryllium mineral. Emerald (green), aquamarine (blue), rose beryl (rose pink), and golden beryl (golden-yellow) are the most precious types. *Strong's Concordance* states that the Hebrew word for "onyx" in Gen. 2:12 is "*sheham*," from an unused root probably meaning "to blanch" and speculates that "this could be taken for a gem, probably beryl (from its *pale* green color)." However, this identification does not appear likely because there is no indication that beryl has ever been mined in Arabia. The closest beryl to Arabia is found in the Red

Table 1. Archaeological Periods in Mesopotamia	
~5000–4000 B.C.	Ubaid
~4000–3200 B.C.	Uruk
~3200–3000 B.C.	Jemdet Nasr
~3000–2750 B.C.	Early Dynastic I
~2750–2600 B.C.	Early Dynastic II
~2600–2350 B.C.	Early Dynastic III
~2350–2150 B.C.	Dynasty of Akkad
~2350–2000 B.C.	3rd Dynasty of Ur
~2000–1600 B.C.	Old Babylonian

Sea Hills at the emerald mines of Sikait and Zabara, just to the west of Luxor, Egypt (Fig. 1).[20]

Rock-Crystal Quartz. Rock-crystal quartz is the macrocrystalline (large crystal) variety of quartz. It is found extensively as veins cutting across rock in Saudi Arabia, such as at the Mahd adh Dhahab gold mine, and it is possible that the ancient writer of Gen. 2:12 considered this quartz (mined along with the gold) to be onyx, especially because of its "cockscomb," onyx-like structure.[21] However, rock-crystal quartz was only used sporadically in Mesopotamia in ancient times,[22] and one wonders why the ancient writer would even mention it along with gold and bdellium if it were not an especially desirable commodity.

The "onyx stone" of Gen. 2:12 is not as easy to place.

Onyx, Agate, Carnelian. Onyx, agate, and carnelian are all varieties of chalcedony, a cryptocrystalline (very finely crystalline) variety of quartz. Carnelian (sometimes spelled cornelian) is a reddish-brown to flesh-colored, unbanded variety of chalcedony. It was a prized material in Mesopotamia, ranking second only to lapis lazuli for use in bead making. Carnelian appears early in the archaeological record (3200–3000 B.C.) at Ur and Jemdet Nasr.[23] It also appears in about 20% of the grave sites in Early Dynastic II–III times (2650–2500 B.C.), along with gold, silver, and lapis lazuli.[24]

Pliny mentioned that "carnelian from Arabia is of the less transparent variety,"[25] but it is not known if Pliny's use of the word conveyed the specific meaning of carnelian or the more generic meaning of onyx. Also, while some carnelian is known from western Arabia, it appears that in antiquity, the substance usually came from the Central Plateau region of Iran—to the east of Mesopotamia rather than to the west of it. Trading posts for carnelian are known to have been the ancient sites of Dilmun (what is now Bahrein) and Harappa (in the Indus river valley of Pakistan). Etched carnelian beads of Harappan manufacture were frequent exports to Sumer.[26]

Onyx and agate are both banded forms of chalcedony. In its strictest mineralogical sense, "onyx" consists of milky-white to white bands alternating with black or deep brownish-black bands, although sardonyx contains white bands alternating with reddish-brown bands. In its linguistic sense, however, "onyx" could refer to either banded chalcedony or agate.[27]

Onyx, sardonyx, and agate have all been cited as occurring on the Arabian Peninsula, but geologists have not verified this yet. Albertus Magnus (~1280 A.D.), in his *Book of Minerals,* said: "Onyx is said to be a gem of a black color; there is found a better kind of it which is black, streaked with white veins. It comes from Medina and Arabia."[28] He also stated in this same book that sardonyx is frequently found in Arabia. Dana's *System of Mineralogy* cites moss agate to be from Mocha in Yemen, which was part of Arabia in ancient times.[29]

Chalcedony in any form was fancied by the ancients, and has been found in Mesopotamia in the archaeological levels dating from about 4000–3200 B.C. onward.[30] It is known to exist in the Western Desert of Arabia and especially in the area of Mahd adh Dhahab-Wadi al Aqiq (Fig. 1). At Mahd adh Dhahab, cryptocrystalline quartz occurs as chalcedony,[31] and as the massive, opaque, rock variety called chert.[32] Chert is color-banded and may have been considered to be a type of onyx. The fact that "*Aqiq*" can mean "agate" in Arabian may be especially significant. Why would an area be named "agate" if agate (onyx) mining had not occurred there?

There is Bdellium

The last commodity mentioned in Gen. 2:12 is bdellium. Bdellium is a fragrant gum resin obtained from plants of the bursera (balsam) family. Frankincense comes from trees of the genus *Boswellia* of the bursera family, while myrrh and bdellium come from trees of the genus *Commiphora.*[33] Bdellium is a substance somewhat similar to myrrh and is often regarded as myrrh—as it was in ancient times when the distinction between these two types was not clear-cut. Bdellium species known from Arabia are *Commiphora mukul* and *Commiphora schimperi.*[34]

All of these kinds of gum-resins (frankincense, myrrh, and bdellium) were used in the ancient Middle East for religious (incense), cosmetic (perfume), and medicinal purposes. Mesopotamian cuneiform texts note that myrrh (bdellium) was used in making poultices for the head; for treating ailments of the eyes, nose, and ears; and for other medicinal purposes.[35] Also, the Sumerians and Babylonians burned incense as part of their temple purification rites. Incense is created by the burning of a variety of gums, resins, and spices to create fragrant fumes.

The trees from which myrrh and bdellium are extracted grew during ancient times only in southern

Arabia and northern Somaliland. Specifically for southern Arabia, myrrh (bdellium) grew within the modern-day country of Yemen from about 18° latitude southward to the Gulf of Aden (Fig. 1), although the Arab geographer al-Maqdisi referred to a bdellium called *muql* which grew in the area of al-Marwah, somewhat north of Yemen.[36] Over time, a substantial incense trade developed between south Arabia and Mesopotamia, Egypt, and other parts of the Middle East, such as Israel and Jordan.

Bdellium is a substance somewhat similar to myrrh and is often regarded as myrrh—as it was in ancient times ...

The Great Arabian Incense Road

When frankincense and myrrh (bdellium) first came into general use in the ancient world is obscure, but the trade of these items was intimately tied up with two things: the establishment of the Arabian incense (spice) route and the domestication of the camel. During the heyday of the incense road, huge camel caravans trudged up and down the entire length of the Arabian Peninsula, carrying precious spices and other commodities to the temples, courts, and markets of the north. Thus came the Queen of Sheba to King Solomon's court carrying (by camel) gold, precious stones, and spices (1 Kings 10:1–13). *"And she gave the king an hundred and twenty talents of gold, and of spices of very great store, and precious stones; there came no more such abundance of spices as these which the queen of Sheba gave to King Solomon"* (1 Kings 10:10).

The Queen of Sheba came from Marib (ancient Mariaba, now part of Yemen), the great and prosperous caravan city which was the capital of the ancient Kingdom of the Sabaeans (Saba means the biblical Sheba). Marib was on the ancient trade route, which began in the south along the Gulf of Aden, and which continued northward past Marib and Najran, then to Abha, Bisha, and Mecca (Fig. 1). From Mecca the old incense road split, with its western route going to Jordan, Israel, and Egypt and its eastern route going past the Mahd adh Dhahab gold mines (stopping at Bir Madid, the "well of the mines"), northeast to the Wadi Rimah, down the wadi to Buraydah, and then along the Wadi al Batin (Pishon River) to Mesopotamia. From the land of Havilah and along the Pishon River, the bdellium (from Yemen), the onyx (from the Wadi al Aqiq-Mahd adh Dhabab area), and the gold (from Mahd adh Dhabab) could have been brought to Mesopotamia, as is suggested by Gen. 2:11–12.

Camel Caravans

A pertinent question to ask regarding the commodities mentioned in Gen. 2:11–12 is: When did trade along the Arabian spice route begin? Scholars agree that by 1100 B.C. trade was well underway, with the Queen of Sheba visiting King Solomon sometime around 950 B.C. When trade began along the Arabian incense route seems to hinge on when the camel (*Camelus dromedarius*) was domesticated in Arabia. The incense route covers a very arid and inhospitable terrain, suitable for camels but not for other beasts of burden, such as donkeys. The date of camel domestication is disagreed upon by scholars. Many favor a date of around 1300–1100 B.C., based primarily on the lack of unequivocal archaeological evidence for an earlier date.[37] However, other scholars cite evidence which places camel domestication long before this—perhaps as early as 2000–3000 B.C. or before.[38]

The Bible itself attests to a probable early date for the domestication of the camel, and hence the export of items like gold, precious stones, and bdellium along the Arabian incense route. Job 6:19 hints at a link between the caravan merchants of Sheba and Tema.[39] Gen. 12:16 states: *"And he* (the Pharaoh) *treated Abram well for her* (Sarah's) *sake: and he had sheep, and oxen, and he-asses, and menservants, and maidservants, and she-asses, and camels."* The date that Abraham lived has been fairly well established (about 2000 B.C.), and thus this verse implies that domesticated camels were already present in Egypt by this time. Abraham also maintained his camel herd after he left Egypt and came back to Palestine. Gen. 24:10 states: *"And the servant took ten camels of the camels of his master* (Abraham) *and departed ...* (to the city Nahor in Mesopotamia to find Isaac a wife)." That these camels were domesticated is clear from the text. Abraham's "goods" were carried by these camels to Mesopotamia (Gen. 24:10), and Rebekah drew water for these camels (Gen. 24:19).

Location of the Pishon River

In summary of this section on the Pishon River, it can be asked: What other location besides Arabia and the Wadi al Batin better fits the description of Gen. 2:11–12? Scholars have suggested Egypt,[40] the Mediterranean,[41] Mongolia, India, Ethiopia, Armenia, Turkey, and even "lost Atlantis."[42] But do any of these places contain all three commodities (gold, onyx, bdellium) as specified by the Bible? Bdellium

only grows in southern Arabia (Yemen) and northern Somaliland, so this item automatically eliminates most of the suggested localities. The headwaters of the Wadi al Batin drain the ancient gold and onyx areas of Mahd adh Dhahab and Wadi al Aqiq, and all three commodities are known to have been transported by camel into Mesopotamia at an early date. Finally, the Wadi al Batin confluences with the Tigris and Euphrates in the land of Mesopotamia just as the Bible states. All of the above is evidence that the Wadi al Batin is the now dry, ancient Pishon River and that the land of Havilah (the son of Joktan, not Cush) is indeed Arabia.

The Wadi al Batin is the now dry, ancient Pishon River and the land of Havilah ... is indeed Arabia.

The Name of the Second is Gihon

The second river of Genesis 2 (the Gihon) is not as easily identified as the Pishon. The problem revolves around the identity of the "land of Cush," which in the King James Version of the Bible was translated "Ethiopia." Not only is this translation questionable, it also does not make sense. A river in Ethiopia would flow to the Red Sea, to the Mediterranean Sea, or to the Indian Ocean, not to a confluence of the Euphrates and Tigris Rivers as stated by the Bible. According to Speiser in the *Anchor Bible Commentary*, the "land of Cush has been mistakenly identified with Ethiopia, rather than with the land of the Kassites."[43] The Kassites (or *kaššû*) people lived to the east of Mesopotamia in the Old Babylonian Period (1800–1600 B.C.; Table 1). Before then, however, this area was known as the land of Elam or Susiana, where the inhabitants of the Plain of Susa lived (Fig. 2). If the Cush intended by the Hebrew word *kush* is the territory of the Kassites, as Speiser claims, then the river referred to in Gen. 10:13 must have come from the east of Mesopotamia, or what today is western Iran.

It Compasseth the Whole Land

The major rivers that run through western Iran (formerly Susiana) are the Karkheh and the Karun (Fig. 2). The Karun is by far the longer of the two, and Iran's only navigable river. These two rivers provided a route of communication between the heart of Susiana and southernmost Mesopotamia. In the third millennium B.C., caravan routes along both rivers went through Susiana to Sumer and Akkad.[44] This important trade route would be familiar to people in the region. Perhaps this is why the writer of Genesis mentioned the Gihon River. Also, the Sumerians were constantly at war with the Elamites, and this is another reason why the Genesis writer would have been apt to mention this river. Everyone living then would have known where the "land of Cush" was located.

Following this reasoning, the most likely candidate for the biblical Gihon River is the Karun. The word "compasseth" in Hebrew means "to revolve, surround, or border, or to pursue a roundabout course, to twist and turn."[45] That is exactly what the Karun River does. It is a meandering river with great bends. Its course is 510 miles long, but its distance (in a bird's-eye view) is only 175 miles long.[46] Since the sedimentary rocks of the Zagros Mountains are folded into great anticlinal and synclinal structures, they create a zigzagging, "roundabout course" for the river as it follows them. Today the Karun contributes most of the sediment which is forming the delta at the head of the Persian Gulf,[47] and it must have done likewise in ancient times. Less likely, the Gihon could have been the Karkheh, which also winds through the land. M'Causland identified the Gihon as the "Gyudes" of the ancients, which is the equivalent of the modern Karkheh joined by the Kashkan river in the region of Kush, later called Khuzestan.[48]

The most likely candidate for the biblical Gihon River is the Karun.

In antiquity, the Karun River formed an estuary with the Karkheh. Until the tenth century A.D., the combined rivers flowed directly into the Persian Gulf at Salaymanan, the location of which is now unknown.[49] Most certainly these rivers would have flowed into the Gulf somewhere east of the Tigris River, or they would have joined in confluence with the Tigris at the Persian Gulf.

The Name of the Third is Hiddekel

The third river of Genesis 2 is the Hiddekel, which is the Hebrew name for Tigris. The Tigris River rises on the southern slopes of the Taurus Mountains in eastern Turkey and cuts a bed almost 1160 miles long on its way to the Persian Gulf. On its journey to the sea, it is joined by a number of tributaries flowing from the Zagros Mountains: the Khabur, Great Zab, Little Zab, Nahr al 'Uzaym, Diyala, Karkheh, and lastly the Karun (Fig. 2). Ar-

riving at Mosul, the river flows through a piedmont region of rather low hills. While the course of the upper Tigris appears not to have changed substantially over the last five thousand years, its lower course has been very unstable (for example, one of its ancient courses was called "Idiqlat" by the Sumerians; Fig. 2).

The Tigris was the great river of ancient Assyria.

The Tigris River floods annually due to the spring melting of snows in the Taurus Mountains. Its waters first begin to rise in March, reach their peak in May, and normally recede in June or July. At Baghdad, the river is about one-quarter mile wide, with a depth at high water of twenty-six feet and at low water of about four feet.[50] The current in flood is about four miles per hour and at low water it is one and one-quarter miles per hour. The river below Baghdad is navigable by boats of some size, while the upper Tigris is more difficult to navigate. The Tigris is capable of flooding over vast areas of land. For example, an overflow of the Tigris River in 1954 submerged the low-lying Babylonian plain for hundreds of miles.

The Tigris was the great river of ancient Assyria. On its banks stood many of the cities mentioned in the Bible, including Nineveh, Nimrud and Asshur (Fig. 2). Gen. 2:14 identifies it as "*that which goeth toward the east of Assyria,*" or the land of Asshur, who was the grandson of Noah (Gen. 10:11). And the Tigris does (and did) flow east of ancient Asshur (now a mound, spelled Ashur; Fig. 2), just as stated in the Bible.

The Fourth River is Euphrates

The Euphrates is identified in Gen. 2:14 as being the fourth river of Eden. The Euphrates drains the western part of Mesopotamia. It starts in the highlands of Turkey, flows southeastward over a limestone hill terrain in northern Iraq, and enters its delta at Hit (about 80 miles west of Baghdad; Fig. 2). Overall, it winds its way over a meandering 1700-mile path on its way to the Persian Gulf. South of Hit, the river has an extremely low gradient. Hit is located more than 500 miles upriver from the Gulf, but is only 175 feet above sea level.[51] At An Nasiriyah, the water level of the Euphrates is only 8 feet above sea level, even though the river still has to cover a distance of more than 95 miles to Basra (Fig. 2). Once Ash Shamiyah is passed, the water of the Euphrates is lost in an immense marshland region, and during spring floods this whole region, from the Euphrates east to the Tigris, can become severely inundated.[52]

The course of the Euphrates River has constantly changed channels in its lower portion. Today the Euphrates flows west of where it did in the third to second millennium B.C. At this time the lower Euphrates (then called by the Sumerians "Purattu") flowed from the ancient city of Sippar, to Kish, to Nippur, to Shurrupak (supposedly Noah's home town), to Uruk, to Ur, and then into the Persian Gulf (Fig. 2).

In summary, geological and biblical evidence suggests that the four rivers of Eden from west to east were the Pishon (Wadi al Batin), the Euphrates, the Hiddekel (Tigris), and the Gihon (the Karun and/or the Karkheh). And while the identification of the Pishon and Gihon Rivers must still be considered as somewhat tentative, the certain identification of the Tigris and Euphrates leaves no doubt as to the approximate location of the Garden of Eden. These rivers locate the Garden of Eden as on a modern landscape at the head of the Persian Gulf— but not the *present-day* head of the Persian Gulf.

Ur, a Seaport?

Sea level throughout geologic time has not remained constant, but has changed depending on whether the ocean water is tied up in the earth's ice caps during glacial periods, or whether the ice caps melt during interglacial periods. Prior to 70,000 B.P., when an interglacial existed in Europe, sea level was about 20–25 feet above today's level and the Persian Gulf must have covered much of what is today the Mesopotamian plain. At about 70,000 B.P., the last ice age (the Würm) began. At the maximum of this ice age (~20,000 B.P.), sea level was 350–400 feet lower than it is today and the entire Persian Gulf (all the way to the Strait of Hormuz) was a dry river valley.[53] Then, at about 8000 B.C. (10,000 B.P.), a warmer, moister climate ensued and sea level rose again. It reached a maximum at about 3500 B.C., when it was approximately six to ten feet higher, and about 150 miles inland from where it is today.[54] Since then, sea level has retreated to its present position in the Persian Gulf.

This last sea level rise and final decline is supported by both the geological and archaeological record. Marine clays and silts (found at a number of localities between modern Fao on the Gulf and Amara about 150 miles inland from the Gulf; Fig. 2) show that a marine or estuarine embayment ex-

tended perhaps as far as Amara during the period between 4000–3000 B.C.[55] Alluvial sediments overlying these marine clays document the regression of the Gulf to its present level. An embayment is also supported by archaeological evidence. The Mesopotamian city, Eridu, has been explicitly described in Sumerian inscriptions as "standing upon the shores of the sea," and Ur (Abraham's hometown, situated only a few miles away from Eridu) was also described as having quays (landing docks) where oceangoing vessels changed their cargos.[56] Both of these cities now lie about 150 miles inland from the Gulf (Fig. 2). As stated by Moorey: "When ancient texts speak of Ur and Eridu as being 'on the sea,' they may well have meant just that, rather than an extended lake tortuously linked with the sea by channels through marshy swamps, as some scholars have argued."[57] After about 2000 B.C., the sea level dropped and the Persian Gulf retreated to its present-day position, leaving former seaports—one after another—high and dry.

Garden of Eden

So exactly where was the Garden of Eden? Assuming a traditional, biblical-genealogy date of about 4000 B.C. for Adam and the Garden of Eden, the four rivers would have confluenced at the Persian Gulf at a position somewhat inland from where the Gulf is today.[58] The Pishon River (Wadi al Batin) now enters the Persian Gulf at Umm Qasr, but the cobbles and pebbles from this fossil river system once extended as a fan from southern Kuwait northward to the vicinity of Ur (Fig. 1).[59] From about 5000 to 2000 B.C., Ur was possibly a seaport located at the confluence of the Euphrates River with the Persian Gulf, and it is also possible that the Pishon River flowed into the Gulf at or near this locality.

Despite much speculation concerning the exact location of the Garden of Eden, it does seem likely that it was located somewhere about one hundred miles northwest of the present-day Basra in Iraq.

The location of the Tigris and Karun Rivers at this time is uncertain. Pliny's *Natural History* states that, during the conquest of Alexander the Great (~340 B.C.), the confluence of the Tigris and Karun Rivers was at Charax, at a distance of one and one-fourth miles from the coast, and that after that time the Karun appears to have shifted its center of deposition to the southeast.[60] Charax was located about eighty miles southeast of Ur, and for a short time represented the location of a temporary seaport on a retreating Gulf.

Despite much speculation concerning the exact location of the Garden of Eden, it does seem likely that it was located somewhere about one hundred miles northwest of the present-day Basra in Iraq. At the latitude of An Nasiriyah, the landscape is dotted with numerous mounds representing ruins of ancient cities, but south of An Nasiriyah, no mounds exist—presumably because the Persian Gulf extended this far inland and the land south of these cities was submerged (Fig. 2).[61] Of all of these ancient mounds, Eridu is archaeologically one of the oldest settlements known in southern Mesopotamia, dating to about 4800 B.C.[62] According to ancient Mesopotamian tradition, Eridu ranks as the oldest city in the world, and it was also regarded as a sacred city. On Sumerian tablets found at Nippur, a list of ten "pre-flood" kings ending in Ziusudra (the Sumerian name for Noah) described Eridu as:

> When the kingship was lowered from heaven the kingship was in Eridu.
> In Eridu, Alulem became King ...[63]

The mound of Eridu is located about twelve miles southwest of Ur (Fig. 2).

A River Rises in Eden

"And a river went out of Eden to water the garden; and from thence it was parted, and became four heads" (Gen. 2:10).

This passage has been problematical for all biblical scholars. The long-established, widely-held view is that a great river rose in Eden and after leaving the garden, split into four rivers including the Tigris and Euphrates. Therefore, some scholars have interpreted the biblical text to mean that Eden was located somewhere in Armenia near the source of the Tigris and Euphrates.[64] However, this locality does not fit with the Pishon River most likely being in Arabia (as discussed previously). And, it also does not fit with an alternate translation of the text. According to the *Anchor Bible Commentary*, Gen. 2:10 should read: *"A river rises in Eden to water the garden; outside, it forms four separate branches."*[65] A river "rises in," not the traditional "went out of" (the wrong tense), is how the Hebrew should be translated according to Speiser. A river that "rises in" Eden strongly suggests ground flow or the rise of subterranean waters (i.e., a spring). And the word "out-

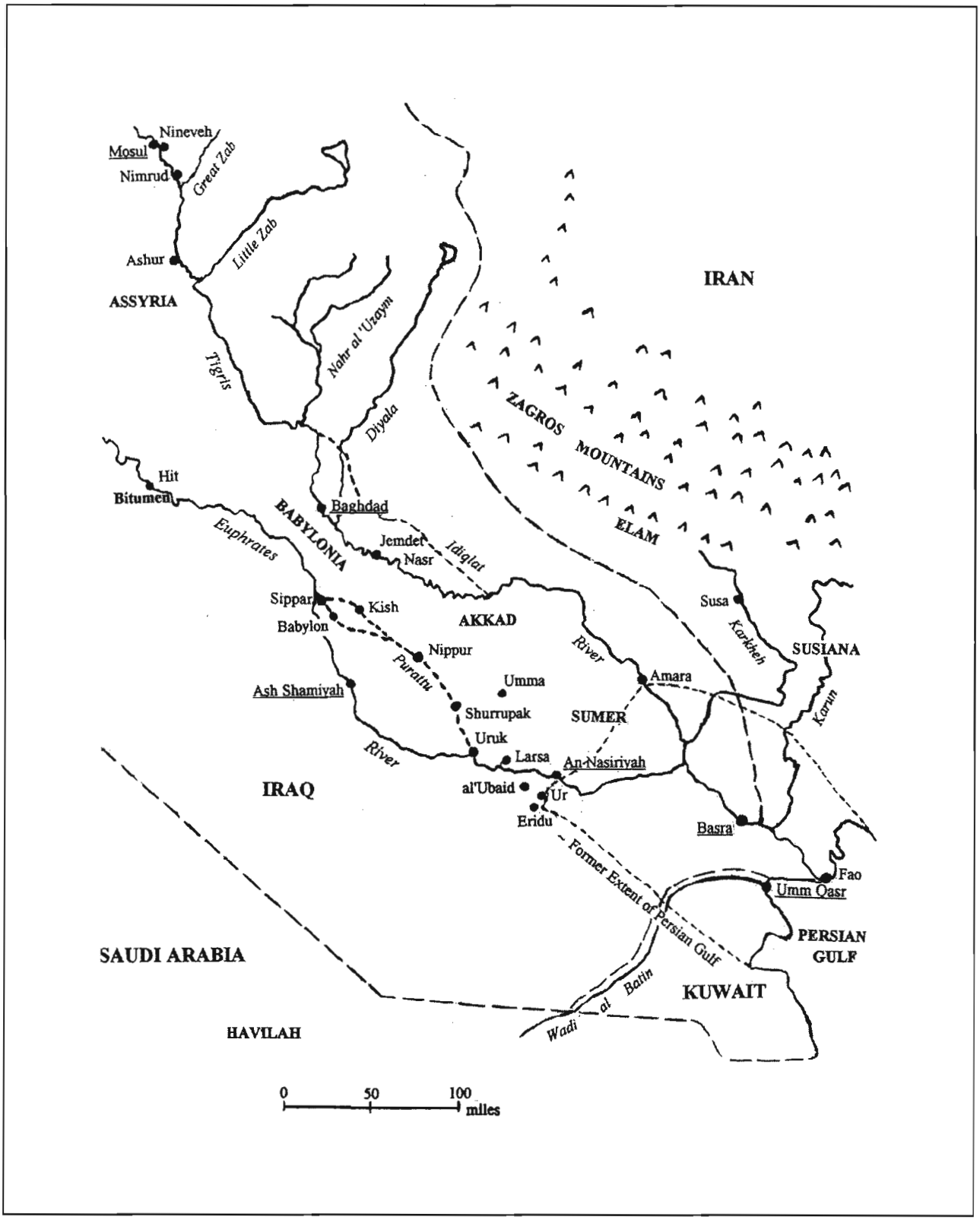

Fig. 2. The ancient regions and cities of Mesopotamia. Present-day cities are underlined. The former courses of the ancient Euphrates (Purattu) and Tigris (Idiqlat) Rivers, and the former approximate extent of the Persian Gulf, are denoted by short dashes. Long dashes denote present-day boundaries between countries.

side" (which in the Hebrew literally means "from there") has the sense of being "beyond it" (Eden). Also, the term "heads" has nothing to do with streams into which the river breaks up after it leaves Eden, but instead designates four separate branches which have merged *within* the vicinity of Eden.

All four rivers—the Pishon, Euphrates, Tigris, and Gihon—once converged near the (then) head of the Persian Gulf to create a fertile land fit for a garden.

A spring rising forth in Eden makes sense. All four rivers—the Pishon, Euphrates, Tigris, and Gihon—once converged near the (then) head of the Persian Gulf to create a fertile land fit for a garden. Not only was this garden located near the junction of these four rivers, but a spring also rose up in the garden to water it. Then the river created by the spring flowed out from the garden to where it met with the confluence of the four great rivers. But what evidence is there for a spring rising in the vicinity of Eridu, a possible locality for Eden?

There is geologic evidence. The Dammam Formation is the principal aquifer (water-bearing rock) for all of Kuwait, Saudi Arabia, and Bahrain. The Dammam Formation is composed of sedimentary limestone rock that covers an extensive part of western Iraq, occurring both on the surface and in the subsurface west of the Euphrates River. The formation is known to crop out only a few miles southwest of Eridu.[66] Thus, a spring in the vicinity of Eridu (Eden?) would not be at all surprising, geologically speaking.

Implications for Flood Geology

So far in this paper, I have argued that the Bible locates the Garden of Eden at the confluence of the four rivers of ancient Mesopotamia. The Bible correctly identifies the Pishon River as draining the land of Havilah (Arabia), from whence came gold, bdellium, and onyx stone. The Bible also correctly identifies the Euphrates and Tigris, both of which are modern rivers which drain approximately the same area of Mesopotamia as they did in ancient times. The Gihon, while not positively identified, is probably the Karun (and/or Karkheh), which "encompasses" (winds around) the whole land of Cush (western Iran). Thus, the Bible locates the Garden of Eden as somewhere near where the head of the Persian Gulf may have existed some 6000 years ago—that is, on a modern landscape similar to that which exists in southern Iraq today.

Six Miles of Sedimentary Rock Below Eden

This interpretation of the Garden of Eden as existing on a modern landscape presents a major conflict between what the Bible says and what flood geologists say.[67] The reason is this: there are *six miles* of sedimentary rock *beneath* the Garden of Eden/Persian Gulf. How could Eden, which existed in *pre-flood* times, be located *over* six miles of sedimentary rock supposedly deposited *during* Noah's flood? What flood geologists are implying is that the Garden of Eden existed on a Precambrian crystalline basement and then Noah's flood came and covered up the Garden of Eden with six miles of sedimentary rock. But this is not what the Bible says. It says that Eden was located where the four rivers confluenced on a modern landscape. It says that the Garden of Eden was located *on top of* six miles of sedimentary rock, and thus this sedimentary rock must have existed in pre-flood times.

[The Bible] says that the Garden of Eden was located on top of six miles of sedimentary rock, and thus this sedimentary rock must have existed in pre-flood times.

The fact that six miles of sedimentary rock exist beneath the Persian Gulf area is well known by geologists, since this area has been extensively drilled for oil, down to the Precambrian basement. The fact that the Persian Gulf is located in an area of oil recovery is equally as evident to the layperson who, in 1991, witnessed on television the numerous oil fires set off in Kuwait during the Gulf War. The six miles of sedimentary rock below the Garden of Eden area include Tertiary, Cretaceous, Jurassic, Triassic, and Paleozoic rock up to a depth of about 32,000 feet before the Precambrian basement is encountered.[68]

A schematic cross-section of rock that exists below the Persian Gulf/Garden of Eden area is shown in Fig. 3. Note in this figure that Precambrian rock is exposed at the surface in the western part of Saudi Arabia (geologists call this the Arabian Shield), and that this rock becomes progressively overlain by a thicker and thicker sedimentary rock cover north-

eastwards, toward Iran. Point A indicates the approximate location of the Garden of Eden according to the Bible and modern geology, and Point B indicates its approximate location according to Flood Geology, since no sedimentary rock supposedly existed at the time of Noah's flood.

Pitch for the Ark

If the above were not evidence enough, there is another Bible passage which confirms a pre-flood Mesopotamian world on a modern landscape. The Bible records that Noah used pitch in construction of the ark: *"Make thee an ark of gopher wood; rooms shalt thou make in the ark, and shalt pitch it within and without with pitch"* (Gen. 6:14).

Pitch is a thick, tarry, oil product composed of a mixture of hydrocarbons of variable color, hardness, and volatility. Bitumen mixed with two or three parts of mineral and/or vegetable matter makes asphalt or pitch, a crude but versatile adhesive. Bitumen is a natural petroleum product derived from kerogen. It can be encountered by oil drillers in the subsurface, or it can move up cracks and faults and make its way naturally to the surface in the form of bitumen seepages.

Many bitumen seeps exist in the Middle East.[69] Bitumen was used extensively by the ancient peoples of Mesopotamia for every type of adhesive-construction need, including the waterproofing of boats and mortar for buildings (e.g., "slime" for mortar; Gen. 11:3). The center of bitumen production in Mesopotamia was (and still is) at Hit, located along the Euphrates River about eighty miles west of Baghdad (Fig. 2). The Hit bitumen occurs in "lakes" where lines of hot springs are welling up along deep faults.[70] This water is sometimes accompanied by so much gas that the latter will burn. In the water, "snakes" of asphalt collect together, and the Iraqis consolidate them into lumps. It is likely that bitumen was collected in this same manner in ancient times, because similar lumps of asphalt have been found at Ur in levels dating from about 3000 B.C.[71] Sir Leonard Woolley's famous expedition to Ur found a

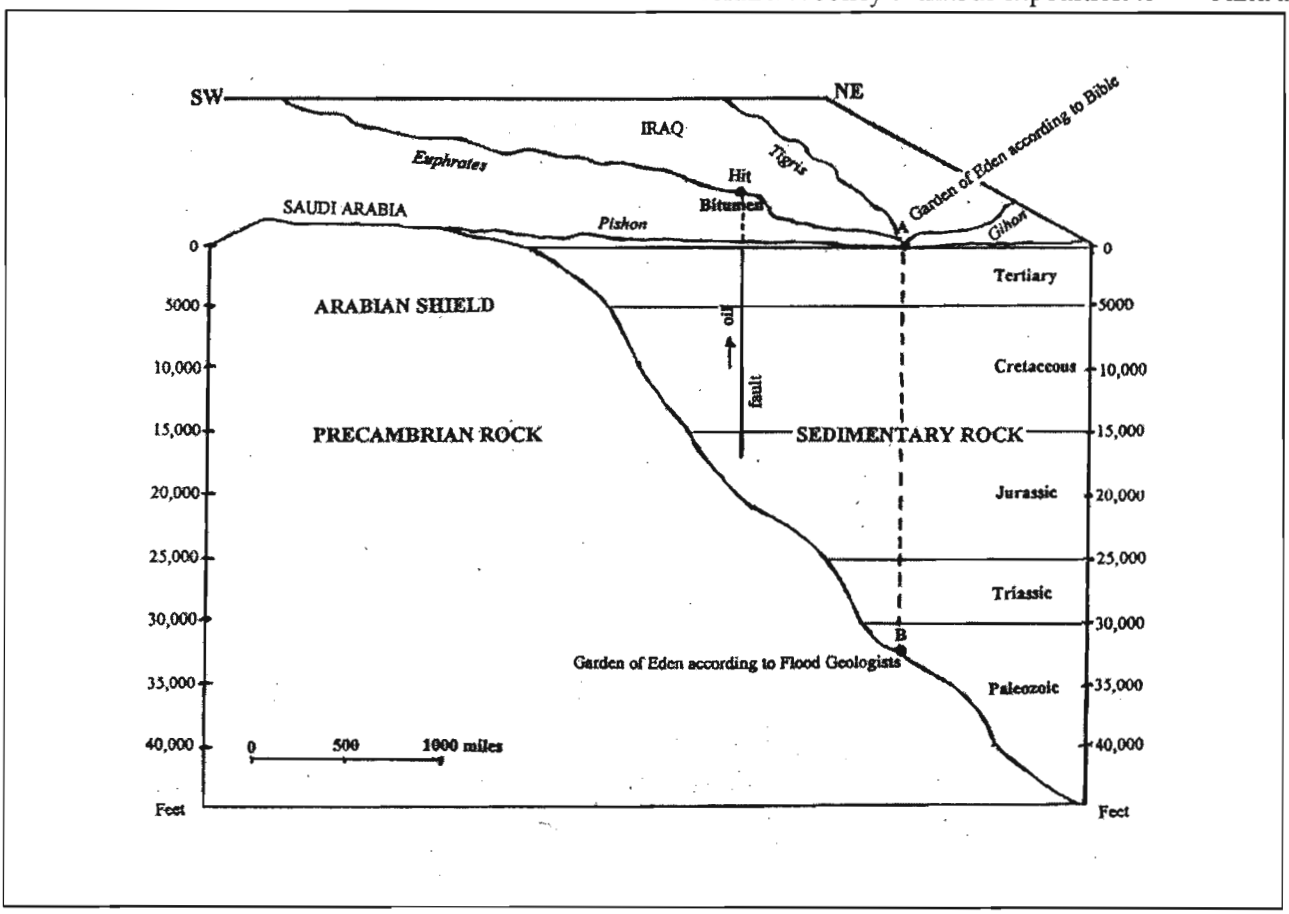

Fig. 3. Idealized diagram of the subsurface geology beneath the Persian Gulf/Garden of Eden area.[72] If all sedimentary rock formed at the time of Noah's flood, as claimed by Flood Geologists, then the Garden of Eden would have had to exist on Precambrian basement rock 32,000 feet (six miles) below where the Bible says it was located.

lump of bitumen just above his "flood layer" which had an imprint of a reed basket on it. Even today, bitumen is packaged into reed baskets and floated down the Euphrates in boats.

The bitumen from Hit has been utilized by the people of southern Mesopotamia for thousands of years, as recorded at numerous archaeological sites. The earliest evidence of bitumen use is at al'Ubaid (5000–4000 B.C.), where reed matting plastered with a mixture of earth and bitumen was found during the excavations of Woolley.[73] Later in the Ubaid Period (Table 1), bitumen-covered headdresses of clay figurine goddesses were made at Ur. However, while some bitumen has been found at very early sites such as these, the bitumen industry (where bitumen was extensively traded) had its beginnings between 3500–3000 B.C.[74] Hit is known to have been the major source of bitumen in southern Mesopotamia because chemical analyses of bitumen collected at archaeological sites compares with that from Hit and not with that collected from sites along the tributaries of the Tigris.[75]

Bitumen was used extensively by the ancient peoples of Mesopotamia for every type of adhesive-construction need, including the waterproofing of boats and mortar for buildings ...

The Sumerians (as noted in their cuneiform writings) definitely connected bitumen with subterranean water.[76] This is because oil oozes up deep faults together with artesian water. These deep faults connect the surface with the source of hydrocarbons at depth—the source being *sedimentary rock* (Fig. 3). In southern Iraq, oil and gas are produced from the limestone and sandstone sedimentary rocks of the Jurassic Najmah Formation; the Cretaceous Yamama, Zubair, Nahr Umr, Mishrif, and Hartha Formations; and the Miocene (Tertiary) Fars and Ghar Formations.[77] In fact, hydrocarbons almost always originate in sedimentary rocks.[78]

The essential point of the above discussion on bitumen now becomes evident. How could Noah have obtained bitumen from sedimentary rock for building his ark, if (as claimed by flood geologists) no sedimentary rock existed on earth? One cannot have it both ways. Either Adam and the pre-floodites lived on a Mesopotamian terrain that was vastly different from what exists today, or they lived over a terrain of sedimentary rock. The Bible identifies Eden with four rivers which flowed *over* and *cut into* sedimentary rock. The Pishon River (when it flowed) cut into Tertiary sedimentary limestone and sandstone rock near the border of Saudi Arabia and Kuwait. The gold of Havilah is in quartz veins that cut across sedimentary-metamorphic rock. The Karun (Gihon?) River winds around folded and faulted sedimentary rock in western Iran, and the Tigris and Euphrates Rivers encounter sedimentary rock throughout their drainage systems, from the mountains of Turkey to the Persian Gulf. And, the spring of Eden (Eridu?) may have been fed by water from a limestone sedimentary-rock aquifer. All of this is evidence for sedimentary rock being present on earth *before* Noah's flood rather than it being formed *by* the flood.

Conclusions

1. The Bible indicates that the Garden of Eden was located on a modern landscape, over which all four rivers of Mesopotamia flowed.
2. The now-dry Wadi al Batin was probably the Pishon River which once drained the eastern side of Arabia (the land of Havilah) when the climate was wetter that it is today.
3. The gold of Gen. 2:11–12 was probably obtained at Mahd adh Dhahab, one of the richest gold mines in the ancient Near East.
4. The source of the onyx stone of Gen. 2:12 may have been the Wadi al Aqiq ("aqiq" can mean agate), which is located near Mahd adh Dhahab and along the Arabian incense route.
5. The bdellium of Gen. 2:12 most likely came from Yemen.
6. Gold, onyx, and bdellium were transported by camel along the Arabian incense road to Sumer. This trade route was probably already established by the time Genesis 2 was written, so the location of the Pishon River (and Eden) was identified for the reader of Genesis by citing these commodities.
7. The Gihon is most likely the Karun River, or less likely the Karkheh, both of which encircled the land of the Kassites (Cush) in western Iran.
8. The Hiddekel (Tigris) and the Euphrates are essentially the same rivers today that existed in Mesopotamia 6000 years ago.
9. Six thousand years ago, the Persian Gulf may have been located as much as 150 miles inland from where it is today, and it might have been at this inland position where the four rivers confluenced near Eden.

10. The river that "rises in" Eden could have been a spring, possibly supplied with water from the Dammam limestone aquifer.
11. Bitumen at Hit was a likely source for the pitch used by Noah in building the ark.
12. The four rivers of Eden *cut across* sedimentary rock. The pitch for the ark was supplied *by* sedimentary rock; therefore sedimentary rock must have existed in pre-flood time.
13. The Bible never claims that *all of the sedimentary rock on the face of the earth was formed at the time of Noah's Flood.* Only flood geologists make this claim. ✠

Acknowledgments

This manuscript benefitted from the comments of Alan Hill, Andrea Hill, Larry Hill, Al Hoerth, Cathe Hoerth, Steve Moshier, and Roger Wiens.

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Toldot Adam: A Little-Known Chapter in the History of Darwinism

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In his autobiography, Darwin mentioned an essay in Hebrew which showed that his theory of evolution "is contained in the Old Testament." Naphtali Halevi (or Lewy) argued in Toldot Adam that Hebrew word choices in the Torah favored evolution, as did some passages in the Midrash Rabbah and the Talmud. Although his argument is not entirely convincing, he proposed interesting alternative interpretations of many biblical texts. Collectively, they suggest that the supposed irreconcilable contradictions between evolution and biblical creation are exaggerated because of an inadequate understanding of the Hebrew text.

Charles Darwin wrote of the reception of *The Origin of Species* that "even an essay in Hebrew has appeared on it, showing that the theory is contained in the Old Testament!"[1] Darwin did not cite the essay, which has remained obscure and untranslated.[2] In the voluminous literature on the apparent conflict between Genesis and evolution, this essay has rarely if ever been cited, yet it is evidently germane to the subject.

In 1876, Naphtali Lewy sent Darwin a copy of his book, *Toldot Adam*, and a covering letter, both in Hebrew. As Darwin could not read Hebrew, he asked Henry Bradshaw, librarian at Cambridge University, to have the letter translated.[3] This incident is one of the few contacts Darwin had with nineteenth century Jewry, then leaving the ghettos for integration into the intellectual, political, and social life of Europe. Lewy hoped to lead his people to the security of a new Promised Land of scientific modernity, protected from assimilation by the link that he believed he had demonstrated between the Torah of divine revelation and the torah (theory) of Darwinian evolution. Thus, this incident offers an illuminating glimpse of the interaction of religion, social conditions, and scientific perspectives.

The Author and his Background

On the title page and on the letter of 1878,[4] the author's name is given as Naphtali Lewy, but on the translation of the letter of 1876, it is given as "Naphtali Hallevi [i.e., the Levite]." In *Toldot Adam*, he referred to his father as "Pinchas Ze'ev Halewy." Finally, Kressel cites him as "Naftali Halevi."[5] Halevi will be used below.

Halevi was born in Kolo, Poland, on September 12, 1840. His father was an important man in the Jewish community, a *dayan* (judge) of the Jewish court. The young Naphtali pursued Judaic studies (Torah, Talmud, and Hebrew) under the tutelage of his father and several rabbis of the Auerbach family, among them Rabbi Meir Auerbach, who later settled in Palestine and became a prominent rabbi in Jerusalem. Subsequently, Halevi went to Posen (Poznan) for secular studies, including science and modern languages. There, he was a student of Rabbi Solomon Platzner.

From 1860 to 1867, Halevi lived in Radom, Poland, where he tutored the children of a rich family. He was also a successful merchant, but toward the end of his years in Radom, he lost his fortune. In 1877, he moved to England, where he ventured into

publishing newspapers: first *The Londoner Israelite* in Yiddish, then *Hakeren* (The Vineyard) in Hebrew. But both soon failed. He then returned to commerce and was sufficiently successful that he was able to retire and devote his last years to scholarship, particularly to Judaic studies. He wrote prolifically in German, English, Yiddish, and Hebrew. He died in Southport, near Manchester, on May 25, 1894.

Halevi wrote in maskil Hebrew, a dialect of the Maskilim, advocates of the Jewish Enlightenment (see below). Over the centuries, Hebrew had become significantly different from that of biblical times. Maskil Hebrew was at once an attempt to restore biblical Hebrew and a first step toward modern Hebrew. Halevi's style was florid and verbose. Although Hebrew is a concise language, requiring only about a third as many words as does English to express the same idea, Halevi wrote very long, involved sentences, the beginning and end of which may be only tenuously related. Second, he quoted the Bible extensively. His 1876 letter to Darwin was less than one page in Hebrew, yet in so short a space there were no fewer than nineteen biblical quotations! One was a single word from a verse that otherwise had no relevance to his message. A final characteristic of Halevi's style was adulation of science and especially of Darwin, whom he addressed as "... the Lord, the Prince, who 'stands for an ensign of the people' (Isa. 11:10), the Investigator of the generation, the 'bright son of the morning' (Isa. 14:12), Charles Darwin, may he long live!"

In 1868, *Ha-Shahar* (The Dawn) was first issued in Vienna. Over the next sixteen years, twelve volumes were published. In 1874, they published Halevi's essay, "Toldot Adam," which was also privately published as a book. The journal editor stated in Vol. 1 that *Ha-Shahar* would promote *Haskalah*, the Hebrew language, Jewish nationalism, and Jewish colonization of *Eretz Israel*, the land of Israel.

Some comments on *Haskalah* are necessary. The word means enlightenment. *Haskalah* was an extension to the Jewish community of the Enlightenment movement in European philosophy. Previously, European Jews had been confined to ghettos.[6] They were not citizens of the countries in which they lived; indeed, citizenship was considered inconsistent with the messianic faith that one day the Messiah would lead all Jews in a triumphant return to the Holy Land. Although Jews were not admitted to the universities, Jewish communities maintained their own schools, in which the curriculum centered on the Torah (the Pentateuch), the Talmud, and the Hebrew language. The language of prayer was always Hebrew, while the social language was Yiddish, written in Hebrew characters. Yiddish is based on Middle High German, but it includes many Semitic words, both Hebrew and Aramaic. Commonly, Jews did not speak the language of the surrounding population. They had their own courts. The law often specified professions forbidden for Jews, but even where this was not the case, they were usually restricted to commerce and finance. Thus, Jewish communities were highly isolated.

Against this background, the Enlightenment saw reason as the most important attribute of humanity and the bond among humans. Since Jews shared this characteristic, they should have been welcomed to share in the intellectual life of the Enlightenment. *Haskalah*, the Jewish Enlightenment, sought to break down the barriers and bring Jews fully into the intellectual life of Europe. G. E. Lessing, a German philosopher and man of letters, wrote much in support of the integration of the Jews, and he highly valued the friendship of Moses Mendelssohn (1729–1786), the father and hero of *Haskalah*. With N. H. Wessely, Mendelssohn and others advocated schools based on the principles of *Haskalah*. Such schools emphasized modern languages, science, and other secular subjects, as well as traditional Judaic subjects.

All of this had political and social consequences. In 1782, Emperor Joseph II issued the Edict of Tolerance, which repealed the anti-Jewish laws of the

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Holy Roman Empire. It opened all trades and professions to Jews, and it offered them great educational opportunities. It was the first of a series of acts that in time achieved political integration of the Jewish communities of Europe.

Halevi himself tried to walk a fine line between Haskalah and orthodoxy, a difficult feat. While emphasizing his roots in orthodoxy, he advocated ideas that were more congenial to the Maskilim.

Mendelssohn and Wessely believed that it was feasible to combine devout Judaism with participation in the intellectual life of the Enlightenment. Not all Jews agreed. Many believed that those who had one foot in each culture would soon compromise their Jewish faith and observance. Their concerns were confirmed when some of the Maskilim asked for the inclusion of some prayers in German, and for other changes in the Jewish service to accommodate the spirit of the times. When Wessely published his proposals for education of Jewish youth, Rabbi Moses Sofer replied in sorrow and indignation:

> ... But now insignificant foxes have risen up ... men who do not submit to the yoke of heaven ... nullify the covenant ... through devious schemes ... they have added to and deleted from the text of prayers ... and significantly the majority of their prayers are in ... German. He who repudiates the oral law ... is classed with atheists ... these men neither anticipate nor believe ... the words of our prophets concerning the building of the Third Temple and the coming of the Messiah ... communal prayer in a language other than the Holy Tongue is completely reprehensible ...[7]

Mendes-Flohr and Reinharz rank Sofer among the milder of the traditionalists who protested against the reforms.

For a century, *Haskalah* was a major factor in the development of Jewish culture. It resulted in the division of Judaism into orthodox, conservative, and reform branches. It culminated in the intellectual, social, and political integration of Jews that characterizes much of the Western world today. In short, it prepared the way for the role of the Jews in today's society.

Sofer saw *Haskalah* as a threat to the integrity of Jewish worship, but an even greater danger was assimilation. It was this that most aroused the antipathy of Jewish traditionalists. It is noteworthy that most of the children and grandchildren of Moses Mendelssohn (including his grandson, Felix, the great composer) became Christians. Halevi himself tried to walk a fine line between *Haskalah* and orthodoxy, a difficult feat. While emphasizing his roots in orthodoxy, he advocated ideas that were more congenial to the Maskilim.

Toldot Adam

"The purpose of this inquiry is to show the meaning of creation according to our great teacher, Moses."[8] Halevi believed that evolution was adumbrated in the Torah, hence he devoted much of his essay to an analysis of the Torah and to commentaries on it in the Midrash Rabbah (Jewish treatises on the Torah and other books of the Bible, written between the fourth and twelfth centuries A.D.).

In 1876, Halevi wrote in his letter to Darwin that his purpose was:

> to teach the children of my people, the seed of Jacob, the Torah (instruction) which thou hast given ... and when my people perceive that thy view has by no means "gone astray" (Num. 5:12) from the Torah of God, they will hold thy name in the highest reverence and at the same time "glorify the God of Israel" (Isa. 29:23).

To paraphrase, he believed that he had shown harmony between the Torah and the Darwinian theory of evolution. In the conclusion of *Toldot Adam*, he wrote:

> Among the youth ... who hold the theory of Darwinism, I have seen those who do not praise the faith of the Creator, and who believe only in materialism, and do not know that ... Darwinism only broadens the limits of creation, and it ascribes high attainment to the sublime Creator ...[9]

Finally, Halevi sought to show that the harmony of the Torah of God and the torah of evolution should strengthen faith in the Creator and protect his people against assimilation.

The title, *Toldot Adam*, may be a play on words. The annual liturgical readings of the Torah are divided into weekly portions, one of which begins "*Aileh toledoth*[10] *Noah*," or "these are the generations of Noah." Halevi may have inferred that he had now carried this back to Adam!

Of the six chapters of the essay, the first three comprise a long introduction. Chapters two and three introduce the scientific method, largely with astronomical and physical examples. Halevi then concludes that humankind is the most essential part of nature, because without humans, nature would not know its own existence.

Halevi's thesis can be considered in three great phases: (1) physicochemical evolution, by which the physical universe was developed, culminating in the origin of life; (2) biological evolution, generating the enormous variety of life, culminating in the origin of humans; and (3) psychosocial evolution of humankind.

Physicochemical Evolution

Halevi saw the evolution of the physical universe in terms of *dok*, a Hebrew word that is not readily translated. It means fineness, thinness, or curtain; poetically, the heavens. The word is not used in Genesis, but only in Isa. 40:22, "He stretcheth out the heavens like a curtain (*dok*) ..." A related Hebrew root, *davak*, means *sticking together*. Halevi visualized a primitive universe of extremely dispersed matter gradually drawn together by gravity, then adhering together to form the heavenly bodies.

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"God created the heavens and the earth, and the earth was void and empty, and darkness was upon the face of the deep; and the spirit of God moved over the waters" (Gen. 1:1-2). The Torah portrays the world at first as a ball of gas, which became liquid, then cooled and formed a solid crust. All of this is encompassed in the words *tohu* and *bohu*, translated as "void and empty" in the Douai version and as "without form and void" in the King James version. Scholars do not agree on the correct meaning of these words. Halevi believed that *waters* meant primitive matter collectively, while *bohu* indicated solidification of the crust. The earth, the other planets, and the stars all float in space, which the Torah calls *tehom*, usually translated as "deep" or "abyss." Halevi used *torah* to mean theory. Did he thereby try to strengthen his theory by relating it to the *Torah*, the divine law? Perhaps. He loved a play on words. His *dok* cosmology is clever, but the absence of the word from Genesis weakens his argument; it contrasts strongly with modern big bang cosmology.

Biological Evolution

Halevi touched on the history of life very lightly in a summary that was inadequate, even in 1874. He believed that animals were derived from plants because fossil plants "hundreds of millions of years older than animals" were known, and because plants like *Volvox* have chlorophyll, yet are mobile like animals. Also animals like corals are predators, although fixed in the environment, suggesting transition from plant to animal. He observed progression from simple to complex invertebrates, and finally to mammals and humans.

Halevi believed that the Torah hinted at vast expanses of time before plants existed. *Terem* is usually translated as "before," but he says that it is vague and may designate long periods, even geological ages. In Gen. 2:5, "And every plant of the field before (*terem*) it was in the earth, and every herb of the field before (*terem*) it grew; for the Lord God had not caused it to rain upon the earth, and there was not a man to till the ground," Halevi saw the evolution of the entire plant kingdom and the geological ages required! Rashi, however, emphasized that *terem* here meant "not yet," so that the verse should read, "and every plant of the field had *not yet* grown ..."[11] Could Halevi's interpretation be maintained with Rashi's reading of *terem*? The translator believes that the indefiniteness of *terem* still permits Halevi's interpretation.

Halevi thought that "there went up a mist from the earth, and watered the whole face of the ground" (Gen. 2:6) meant that nature carpeted the earth with plants. Since plants use carbon dioxide, release oxygen, and fix nitrogen, they prepare the habitat for animals and humans, and train them to evolve. Thus, plants act as the natural mother of humans. Halevi thought that the Torah suggested all of this by the "mist that went up from the earth." He found this interpretation confirmed in the Midrash.

Neanderthal remains were first found in 1848, and Cro-Magnon remains at Les Eyzies in 1868, but Halevi mentioned neither. He did write about skeletons found in Danish kitchen middens and in the Mississippi delta, for both of which he accepted dates of 30,000 years B.P. Such antiquity helped him to accept an evolutionary origin of humans.

When the Torah speaks of the actions (*ma'aseh*) of the Lord, it means transformation, variation, or the

emergence of species by the laws of nature. Moses wrote: "*Bara Elohim la'asot*," translated "God created and made" in the King James version, but "God created to make" would be more accurate. The words were carefully chosen, for *la'asot* and *ma'aseh* are derived from the same root. What science calls transformation, the Torah calls *yatsor*, as in Gen. 2:7, "The Lord formed man ...," that is, he gave changed form to pre-existing matter (*cheres*, clay or matter). "Shall the work (*yotsar*) say to him that made it (*yotser*) 'Thou madest me not?'" In German, this suggests *formen* or *bilden* (to give form to something). From this root, we find "*tsiyur charsei tsirim*," "*makers of idols*"; "*nahafchu tsirai 'alai*" (Dan. 10:16), "my sorrows are turning upon me"; and "neither is there any rock (*tsur*[12]) like our God" (1 Sam. 2:2), which our ancestors explained as "neither is there any artist (*tsayyar*) like our God, who draws a picture within a picture." These phrases suggest progressive change, especially if, as Halevi believed, the words for form, picture, sorrow, and rock all have the same root. This has been disputed because Hebrew roots normally have three letters, while some of these words have only two. Nonetheless, the same consonants are repeated, and to Halevi this suggested relationship. The translator found the argument persuasive in Hebrew, but not in English, for the roots are unrelated.

Halevi was confident that Jews of biblical times understood that the* nefesh chayyah *of newly created humans was that of an animal.

Halevi noted that all scientific authorities derive *Homo sapiens* from apes, and between the lines of the Talmud, he found that humans resemble apes in body and in sin. "And man became a living soul" (*nefesh chayyah*, [Gen. 2:7]). Commenting on this verse in the Midrash, Rabbi Yehuda said that God made humans a tail, then took it away because of his honor. (Embryos of all primates develop a tail, but the tails of humans and great apes are resorbed before birth.) Halevi considered the tail to be a hallmark of animal origin. He returned repeatedly to the phrase *nefesh chayyah*, translated as "living soul," but he stressed that *chayyah* alone usually refers to lower animals. He was confident that Jews of biblical times understood that the *nefesh chayyah* of newly created humans was that of an animal.

Psychosocial Evolution of Humankind

The newly created *nefesh chayyah* lived like other animals for thousands of generations. "Our Torah does not count this time, but in it, a thousand years are as one day ... It is a cornerstone of our article that all that was created in six days needed further work—even man."[13] What we call instinct, the Torah calls *nefesh chayyah*. It is the source of obligatory will, not of free will. The root *nefesh* is found in several verses. Gen. 23:8, "*im yesh nafsheichem*," is translated as "if it be in your mind," and Deut. 21:11, "*veshalachta la-nafshah*," is translated as "and hast a desire unto her." In these verses, the root means "will." Isa. 5:14, "*herchiva She'ol nafshah*," is translated as "hell hath enlarged herself." Soul (*nefesh*) without knowledge is instinct. Thus, *nefesh chayyah* means that humans were like animals, without choice or free will. Halevi found this confirmed in the Midrash Rabbah (chap. 14).

For Halevi, migration was a key process of evolution because it exposed organisms to new selective forces. This led to "perfection," a common idea among nineteenth century advocates of evolution. He found a suggestion in Gen. 2:8 that humans originated far to the east, then migrated to Eden. The garden was flowing with rivers, ever the ferries for plant migration, thus making the garden truly *Eden* (delight). Halevi believed that the phrase, "And the Lord God took man" (Gen. 2:5), was understood in biblical times in terms of migration. Isa. 14:2, "And the people shall take them and bring them to their place (*lekishah*)" clearly refers to transferring people from place to place. Num. 33:11, "I took thee to curse mine enemies," similarly means, "I took thee from thy place and brought thee here ..." Therefore, Halevi found migration to be important both in biblical history and in human evolution.

"And He put him in the Garden of Eden to dress it and keep it" (more literally, "to work it and guard it") (Gen. 2:15). This phrase hides the struggle for survival. In Eden humans were enemies to the animals that were already there. The struggle for life includes interdependencies, as predator and prey. Growth of a species is limited by the scarcity of food and by predators. The struggle for existence taught humans how to succeed and to leave descendants in Eden. Necessity and competition brought them knowledge and understanding. They had to work the garden and guard it against competitors.

The Torah treats the knowledge of the sources of food as the first gift to primitive humans: "Of every tree of the garden thou shalt eat." But this gift to the

nefesh chayyah was conditional: "But of the tree of knowledge of good and evil thou shalt not eat. For in what day soever thou shalt eat of it, thou shalt die the death" (Gen. 2:17). As long as humans were only *nefesh chayyah*, they were protected from the knowledge of death. After they disobeyed, they knew that they must die. God commanded; humans did not listen (or obey: *sham'a* may mean either). The Torah attributes all acts of nature directly to God. If the commanding voice is instinct as humans emerged to a life of understanding, then they turned their back on instinct and made a free choice. To the Lawgiver, this is "the fall of man"; to the philosopher, it is the beginning of moral life. Humans now knew that death hunts them down. They might have been happier without this knowledge, which diminished the sense of success of this *nefesh chayyah* that had lived in the land for thousands of years.

For Halevi, migration was a key process of evolution because it exposed organisms to new selective forces.

The origin of language was very important in human evolution. Halevi found it mentioned in Gen. 2:19, "... He brought them to Adam to see what he would call them; and whatsoever Adam called every living thing, that was the name thereof." Halevi discussed the origin of language at length, largely in terms of onomatopoeia, with many examples from Hebrew and German. Beyond that, his hypotheses are no longer tenable.

Finally, Halevi turned to the origin of marriage and the family. Primitively, women were more abundant that men (perhaps even more so than today), so several women, called helpers or helpmeets (*'ezer ke-negdo*, literally, helper against him, which rings true in Hebrew but not in English), joined one man and demanded shelter. In return, they offered him tenderness, repose, and lovemaking. Adam did not consciously choose a mate. Our Torah, ascribing all acts of nature to God, says: "And the Lord God caused a deep sleep to fall upon Adam" (literally, "the man"). The lust that caused that sleep is hidden in the Divine Presence. In the Midrash Rabbah (chap. 17), the word for women is *tsla'ot* (plural of *tsela'*, rib), alluding to the formation of Eve from one of Adam's ribs. According to this Midrash text, *tsela'* is a synonym for woman. Continuing in Genesis, "He took one of his ribs (i.e., one of his women) and closed up the flesh thereof." Thus, Adam chose one woman to be his mate. There is a play on words here in Hebrew that is impossible in English.

The Torah may favor multiplication of savage humans in the primitive world, but from among thousands, one couple gave rise to perfected (evolved?) humankind. At first, man did not recognize the child of that marriage as his as well as hers. Attainment of that knowledge is another important step in evolution. The verb *to build* also means to have sons. In Hebrew, it consists of three letters: *bet-nun-he*. Here in Genesis, the word has two letters, *bet-nun*. *Son* consists of the same two letters, so there is again a play on words that is lost in English. *Ibaneh* (Gen. 15:2) has the same root, as do *ben* and *bat* (son and daughter). Seeing the sons built from his wife and himself, he exclaimed, "Bone of my bone! Flesh of my flesh!" From now on, *'ezer* and *tsela'* are not words for his mate. Man (*ish*) and woman (*ishshah*) are united in marriage (*ishshut*). Again, there is a subtle play on words, all based on the same root, that is not possible in English.

The Midrash Rabbah (chap. 18) comments on the word *vayyiben* in Gen. 2:22, "And he built ..." God built in Eve chambers so that she could conceive children, and he taught her to understand (*binah*, from the same root as *vayyiben*). Verse 24 says, "Therefore shall a man leave his father and his mother, and cleave unto his wife, and they shall be one flesh." This means that they shall cleave to the place where both form one flesh, wrote the Midrash author. In the final verse, "they were both naked, and were not ashamed." *Boshet* can mean either "shame" or "the pubic area."

Halevi ended his essay with some generalities, a quotation of the final paragraph from *The Origin of Species*, and a plea for toleration of his ideas, which, although they may sound strange to those whose education was traditional, are offered for the benefit of his people. For a range of Jewish reactions to Darwinism, see Cohen,[14] Dubin,[15] and Swetlitz.[16]

Evaluation and Conclusions

Translation tends to lose the subtleties and inferences of the original language. In every language, there are idioms that cannot be exactly translated into other languages. In the Bible in particular, because it is presented as the inspired Word of God, specific word choices from a group of near synonyms may have profound importance for interpretation. Rabbi Sofer wrote that "our sages of blessed memory said that the world was created in Hebrew." Accordingly, subtleties of Old Testament

texts may be hidden from those who cannot read Hebrew. Similarly, the New Testament is most meaningful to those who read it in Greek.

Halevi's argument depends upon the subtleties of Hebrew vocabulary, for he believed that some of the word choices in the Torah were favorable to evolutionary interpretation. Because he was profoundly convinced of the truth of modern science and especially of Darwinism, and because he was committed to the Torah as the Word of God, he believed that we could render due honor to Moses, who transmitted the Torah, only if we admit that the words of the Torah were indeed chosen to adumbrate evolution.

Halevi's argument depends upon the subtleties of Hebrew vocabulary ...

Physicochemical evolution Halevi envisioned in terms of *dok*, *tohu*, and *bohu*. The tenuous gas (*dok*) of primitive space (*tehom*) first condensed to form a liquid ball, then a solid crust of earth (*tohu* and *bohu*). Difficulties with this scheme, which was plausible in 1874, include the absence of the word *dok* from Genesis and doubts about the exact meanings of *tohu* and *bohu*.

Halevi's treatment of biological evolution was inadequate even in his day. For the most part, he did not attempt to find it in the Torah, except for the hint of plant evolution in Gen. 2:5. He assumed that phylogeny was so well attested by science that it must be accepted as true. He found hints of the derivation of humans from apes in the Talmud and Midrash. In the latter, he found the statement that a human was first given a tail, then it was taken away "because of his honor." Embryology supports the fact, if not the explanation. Halevi considered the tail to be a direct link to lower animals.

Perhaps Halevi's most emphatic point is the designation of the newly created human as *nefesh chayyah*, and he emphasized that *chayyah* unmodified means a lower animal. He concluded that the phrase inferred origin from animal forbears, and he found this confirmed in the Midrash. Another emphatic point is the distinction between *bri'ah* and *yotsar*, both of which are translated as "to create." Creation *ex nihilo*, as in Gen. 1:1, is always *bri'ah*, whereas creation from previously existing materials is *yotsar*. In Gen. 1:27 and 2:7, *yotsar* is used for the creation of Adam (the man). Taking this with *nefesh chayyah*, Halevi concluded that the pre-existing material from which God made Adam was a lower primate. However, *bri'ah* is used for the creation of humans in Gen. 5:1–2, so there is some overlap in word choice. Traditionally, exegetes had held that *yotsar* was used because humans were molded from inanimate matter. In contrast, Halevi argued that the sacred text favored living intermediates between inanimate matter and humans, that is, evolution of *Homo sapiens*.

Halevi treated psychosocial evolution in great detail. His ideas on the origin of free will and moral life, on the relationships between the sexes, and on the origin of marriage and the family are interesting and original. Some of them may even be right!

Halevi's major argument, however, is that word choices in the Torah were planned to suggest evolution, or at least to harmonize with it, when, thousands of years after Moses, knowledge of evolution and the origin of species would be gained. Did he make this point successfully? My translator, who looks at the question from the viewpoint of a linguist, found Halevi's argument persuasive in Hebrew, but not in English, because words that share roots in Hebrew are usually unrelated in English.

Halevi had unbounded enthusiasm for his theory, his *torah*, and such enthusiasm may dull the edge of critical thinking. He made the most of every possible evolutionary inference in the words of Torah, but at times he made more than is actually there. As a lifelong student of evolution and a practicing Catholic, I would have been pleased if I had found his argument convincing that evolution was, indeed, "contained in the Old Testament." I regretfully conclude that Halevi failed to demonstrate this. He did, however, suggest interesting alternative interpretations of the Hebrew text of the Torah. In some passages, the subtleties of the Hebrew word choices do, indeed, seem to support his thesis. Collectively, these show that Genesis and evolution may not be mutually exclusive, a conclusion shared by many others on other grounds.

Summary

Toldot Adam, a long essay in Hebrew by Naphtali Halevi (or Lewy), is the one that Darwin mentioned in his autobiography as "showing that the theory (i.e., evolution) is contained in the Old Testament!" Halevi's argument is based on inferences of specific word choices in the Hebrew text of the Torah, with supplementary evidence from the Midrash Rabbah, and limited evidence from the Talmud. While his argument is not conclusive, he did propose interesting

alternative interpretations of many biblical texts. Collectively, they suggest that supposed irreconcilable contradictions between evolution and the account of creation in Genesis may be exaggerated because of inadequate understanding of the Hebrew text. ✠

Acknowledgments

I am indebted to many people for help in this research: to P. J. Gautrey, until 1989 responsible for the Darwin Collection of the Cambridge University Library, for copies of Halevi's letters to Darwin; to his successor, A. J. Perkins, for much valuable supplementary information; to Dr. Saul Wischnitzer for help in locating *Toldot Adam*, and for extensive help with the Hebrew text; to Carla Hagstrom, Head of the Reference Department of the University of Toronto Library, for a xerox copy of *Toldot Adam*; to Dr. David C. Dodson for a xerox of *Toldot Adam* from the Harvard Library; to the University of Ottawa Research Services and its Director, Dr. Jean Farrell, for a grant for translation; to Adreshir Mehta for an excellent translation and for many valuable notes on the Hebrew text; and to Dr. Donald J. Weinshank for an interesting suggestion about the title of *Toldot Adam*. Finally, Professor Lois Dubin of Smith College read the entire manuscript and offered many valuable suggestions for revision. Many of the merits of this paper derive from her good help, while its defects are my own.

Notes

[1] Charles R. Darwin, *The Life and Letters of Charles Darwin: Including an Autobiographical Chapter*. Edited by his son, Francis Darwin. (London: John Murray, 1897); and ——, *The Autobiography of Charles Darwin*. Edited by his granddaughter, Lady Nora Barlow (New York: W. W. Norton, 1958).

[2] Naphtali Lewy, "Toldot Adam," *Ha-Shahar* 6 (1874): 3–60. This essay was also privately published as a book.

[3] The book is no longer in Darwin's library, but the letter, translated by a "learned rabbi" whose identity is unknown, is in the Darwin collection of the Cambridge University Library. The letter was published by Francis Darwin (Francis Darwin, ed., *More Letters of Charles Darwin*, vol. 1 [London: John Murray, 1903]. See especially letter 277, pp. 365–66) and summarized by Burkhardt and Smith (F. Burkhardt and S. Smith, eds., *A Calendar of the Correspondence of Charles Darwin, 1821–1882* [New York: Garland Publishing Co., 1985]. See especially letters 10430 and 11509). Lewy wrote a second, unrelated letter to Darwin in German, and this was also summarized by Burkhardt and Smith. These letters made it possible to trace the place (Vienna) and the journal of publication, *Ha-Shahar*.

[4] I obtained a copy of the essay from *Ha-Shahar* and had it translated into English. The Hebrew title page is followed by one in German that translates as "The origin and development of man. Studies on the biblical account of creation."

[5] Getzel Kressel, *Lexicon of Modern Hebrew Literature* (Tel Aviv, 1967). See article on Halevi.

[6] Jacob Katz, *Out of the Ghetto: The Social Background of Jewish Emancipation, 1770–1870* (Cambridge: Harvard University Press, 1973).

[7] P. R. Mendes-Flohr and J. Reinharz, eds., *The Jew in the Modern World. A Documentary History* (New York: Oxford University Press). This work contains about 250 original documents in English translation.

[8] Lewy, "Toldot Adam."

[9] Ibid.

[10] This word is transliterated in several different ways: *toldot*, *toldoth*, *toledot*, and *toledoth*.

[11] Rashi (*Ra*bbi *Sh*lomo ben *I*saac, 1040–1105) was a French rabbi who is described in the *Encyclopedia Judaica* as the greatest commentator on the Torah and other sacred literature. See articles in this encyclopedia on *Ha-Shahar*, *Haskalah*, Moses Mendelssohn, and Rashi.

[12] *Tsur* (rock) is used as a synonym for God in Hebrew. This played an important role in the founding of modern Israel. The writers of the Declaration of Independence included both observant Jews and atheists. The latter wanted no mention of God in the document, while the former wanted full acknowledgment of the Jewish religious heritage. They compromised by using *Tsur*.

[13] Lewy, "Toldot Adam."

[14] Naomi Cohen, The challenges of Darwinism and biblical criticism to American Judaism, *Modern Judaism* 4:2 (1984): 121–57.

[15] Lois Dubin, "*Pe'er Ha-adam of Vittorio Hayim Castiglioni*: an Italian chapter in the history of the Jewish response to Darwin." In *Jewish Studies* 14 (1995): 87–101. Yakov Rabkin and Ira Robinson, editors.

[16] Marc Swetlitz, "American Jewish Responses to Darwin and Evolutionary Theory, 1860–1890," in *Disseminating Darwinism: The Role of Place, Race, Religion, and Gender*, ed. Ronald L. Numbers and John Stenhouse (Cambridge: Cambridge University Press, 2000), 204–46.

Addendum

Xerox copies of the Hebrew text of *Toldot Adam* and its translation have been given to the Darwin Collection of the Cambridge University Library; the Library of the University of Ottawa; the Center for Judaic Studies of Boston University; and to Dr. Sid Leiman, Department of Judaic Studies, Brooklyn College, SUNY. A copy of the translation also has been given to the University of Toronto Library.

Finally, I am no longer alone in my interest in *Toldot Adam*. Dr. Ralph Colp and Dr. David Kohn, of Columbia University, have also had the paper translated and are preparing a study of it. Also, I have given a copy of the translation to Dr. Marc Swetlitz, of the Department of the History of Science, University of Oklahoma, for his research on the Jewish response to Darwinism. If all of these researches are published, and I hope that they will be, then this long obscured chapter in the history of Darwinism may finally become well known and understood.

Communications

God's Design Plan in Nature: A Fresh Look at Altruism

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Altruism has been defined as any action that increases the fitness of the recipient at the expense of the giver.[1] Fitness is defined in Darwinian terms as the potential for an organism to spread its genes to the next generation.[2] Earlier generations of behavioral biologists, observing the way social animals helped each other, came to the conclusion that they were acting for the good of the group or species as a whole.[3] This theory has been displaced by the view that altruism can be wholly accounted for by the Darwinian process of mutation and natural selection acting on an individual to increase its own fitness. One of the strongest advocates of the "selfish gene" theory is Dawkins, who pointed out that natural selection works on genes, not individuals and, certainly, not on groups.[4]

Belief in the "good of the species" view, therefore, is incompatible with the Darwinian concept of survival of the fittest. Altruism in humans and other species is thought to come about through Darwinian mechanisms in the following ways:

- **Kin selection:** Individuals help those in their group because they are likely to be related. In this way, they are spreading genes for altruism through their kin. While this is important in social insects and some other animals, it is not thought to play a major role in human behavior.[5]

- **Group selection:** This should not be confused with the "good of the species" idea discussed above. Rather, this concept postulates a Darwinian mechanism acting through the group. Chance effects mean that some populations have a higher percentage of an altruistic allele than others. Because altruism is good for the group as a whole, these populations prosper and multiply, even though the proportion of altruistic alleles in each group goes down. Individuals from the prosperous groups outnumber those from groups with a lower percentage of altruistic individuals, so the altruistic allele increases in the overall population. Such a mechanism only operates if the sacrifices made by the altruistic individuals are small relative to the group benefit.[6]

- **Reciprocity:** In many groups, animals give favors to one another in the expectation that they will be repaid. When there is a delay between the favor and its repayment, there is selection pressure for "cheat" genes to evolve. We would, therefore, expect cooperation among group members to fall apart as the "cheats" become dominant in the population.

  Computer simulations, however, show that "cheats" are rapidly displaced by individuals who remember who they have done favors for and keep account of old scores ("tit for tat" strategists). Individuals may also remember who has done favors to other group members, and only help those who are cooperative.[7]

  The evolution of reciprocal altruism through Darwinian mechanisms alone could only apply in a species like ours which lives in groups, and is intelligent enough to remember the faces and

characteristics of other individuals.[8] Another assumption is that there are repeated interactions among group members. Those who act altruistically, therefore, must live to learn from the experience.[9]

Weaknesses of Darwinian Mechanisms

Some people are quite obviously uncomfortable with the idea that all human morality can be reduced to the random action of selfish genes. Even Dawkins, a strong advocate of Darwinism, appears unable to accept the inevitable logical conclusion of his arguments, holding to the view that perhaps in the human species a real disinterested altruism can be nurtured.[10]

Quite apart from the gut feeling that mere Darwinism is not enough, if we examine cases of altruistic behavior in more detail, we can see that the assumptions of high intelligence, sociability, and repeated interactions needed for Darwinian evolution to take place are not always present. A classic example of reciprocal altruism is the case of cleaner shrimps or cleaner fish and their clients on coral reefs.[11] The cleaners live on parasites that they pick from inside the mouths of predators such as barracudas. The predators welcome this attention, and allow the cleaners full access to the insides of their mouths without even attempting to molest them afterwards. Predators have even been observed to put their own lives at risk rather than harm the cleaners. Predators recognize the sites occupied by the cleaners and return to the same site again and again. Trivers argues that it is this site recognition that fostered the selection of behavior that prevents the predator from eating the cleaner.[12] Predators will not damage their own property.

This presupposes that each predator is allocated only one cleaner, but there is no experimental evidence to support this view. Indeed, Trivers describes predators that have a number of alternative sites where they can attend, if their regular cleaner does not appear.[13] Certainly, it would be inconvenient for a predator to lose its cleaner, but if it shares the cleaner with other predators, it would be in the predator's interest to eat the cleaner before one of its competitors does. "Cheat" predators would, therefore, be selected for. Such attitudes to communal property among humans have been well documented as the "tragedy of the commons."[14]

Another case of reciprocal altruism is the example of certain ant species that carry caterpillars into their nests, feed them, and look after them in order to get the sweet, nectar-like substance which the caterpillars excrete. The interesting thing about the relationship is that even when the caterpillar has outlived its usefulness and has pupated just outside the ants' nest, the ants will not harm the pupa, and will even continue to look after it.[15] Again, such behavior would not be advantageous from a Darwinian point of view, since the caterpillars in the next generation are shared among all ant colonies in the area.

Altruism has even been seen in supposedly nonsentient plants. Recent research suggests that plants secrete substances when under attack by insects. These warn other plants nearby so they can prepare their defenses.[16] Similarly, some plants produce estrogen mimics. These inhibit reproduction in herbivores, and therefore benefit all plants in an area, even though the donor still gets eaten.[17]

Altruism as a Design Plan

If we look around at the living world, we certainly see evidence of ruthless competition. However, we also see many instances of altruism and cooperation, from the heroic acts of humans, to the actions of cleaner fish and their clients, to the intricate relationships of all components of an ecosystem eloquently described by E. O. Wilson.[18] The regulation of the biosphere has prompted the theory that the earth itself is an interacting system with all parts playing their role.[19] At the cellular level, too, there is increasing evidence to suggest that the cells which make up our bodies are the results of cooperation between a eucaryote and bacterial cell.[20]

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Many biochemical systems cannot be explained through the gradual selection process required by Darwinism, leading to the conclusion that organisms are intelligently designed, at least at the cellular level.[21] However, evolutionists can also explain design by invoking mechanisms, such as complexity theory, to supplement the Darwinian process. Design is not denied, but is attributed to chance effects or to "Mother Nature."[22]

What is needed is a way to distinguish the identity of the designer through a study of the design. I suggest that the ubiquitous presence of altruism and cooperation provides one such test. If design is a product of random processes, then we should not expect it to show any evidence of cooperation or any altruistic interactions that cannot be explained by a Darwinian mechanism. If life was designed and created by a loving God, however, it would not be surprising to find that altruism and cooperation have been built into the design plan.

My conclusion, therefore, is that altruism provides proof of God's creation, as stated in Rom. 1:20. The Creator has designed all of us, human and nonhuman, so that we can "love one another as I have loved you." ✠

Acknowledgments

This article was inspired by discussions at the 4th World Congress of Bioethics, Tokyo, 1998, particularly with Dr. A. Pollard (Macaquarie University, Australia) and Dr. Darryl Macer (Tsukuba University, Japan), who reviewed an early version of this manuscript.

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"It's beginning to show *some* human characteristics—faulty reasoning, forgetfulness and repetition."

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Book Reviews

Faith & Science

ROCKS OF AGES: Science and Religion in the Fullness of Life by Stephen Jay Gould. New York: Ballantine, 1999. 241 + viii pages with index. Hardcover; $18.95.

Harvard Professor of Geology Stephen Gould is well known for his technical work relating to evolution and for his popular writings on natural history. His name should be familiar to those involved in science-theology dialogue, especially in connection with issues relating to creation and evolution. Gould has been very critical of "creation science" and related movements. While he has generally been civil in his statements about religion, in contrast to someone like Richard Dawkins, his agnostic-leaning-toward-atheist position has also been fairly clear. It would be easy to assume that he would really like to get rid of religion.

For those who have made such an assumption, the present book will come as a surprise. Gould proposes here a principle of Non-Overlapping Magisteria (NOMA) to distinguish the domains where the forms of teaching of science and religion are appropriate. "[The magisterium] of science covers the empirical realm: what is the universe made of (fact) and why does it work this way (theory). The magisterium of religion extends over questions of ultimate meaning and moral value. These two magisteria do not overlap, nor do they encompass all enquiry" (p. 6). He sees this as a simple way of eliminating conflict between the magisteria and allowing each to focus on its proper concerns.

This type of proposal is not new, being the second of four ways of relating the two areas which Ian Barbour set out in *Religion and Science: Conflict, Independence, Dialogue, and Integration*. The Independence view has been taken by a number of modern theologians, such as Bultmann, for whom religion as a matter of personal faith is not really concerned with the natural world, and by those who distinguish science and religion as different "language games." It is hard to avoid the suspicion that some theologians find this approach attractive because it avoids the possibility of the types of embarrassment that happened with Galileo and Darwin. Gould is not making a parallel attempt to avoid attacks from religion, being realistic enough to know that proponents of "Bible science" and similar notions will pay little attention to his arguments. He simply thinks that while science and religion are both interesting, they are totally disparate realms.

As one would expect, Gould discusses "modern creationism" as "a distinctively American violation of NOMA" (p. 125 ff.). But his treatment of Bryan and the Scopes trial brings out the fact that the text which Scopes used to teach evolution violated the principle from the other side by making assertions about the superiority of "the Caucasians" to other races. "Bryan advocated the wrong solution," Gould says, "But he had correctly identified a serious problem."

As a proponent of the Independence view, Gould makes pointed criticisms of other ways of relating science and religion. He demolishes the fallacy that everybody in the Middle Ages thought that the world was flat on his way to demonstrating that Draper's and White's Conflict or "warfare of science with theology" view was greatly overstated. His criticisms of the Integration view, which he labels syncretic, are more current, zeroing in on some recent reports about science-theology dialogue and the Templeton Foundation.

Genuine syncretism, which tries to erase the distinctions between science and religion, should be rejected, but Gould overstates the case, attacking what seems to me appropriate dialogue between the two. Non-overlapping magisteria should not mean that there could be no points of contact or flow of ideas between the two.

A serious problem with Gould's proposal is that, in the Enlightenment spirit of a total fact-value split, religion would finally be unable to say anything about the physical world, and thus have doctrines of creation or eschatology without any real content. It is certainly true, as Gould argues in Chapter 4, that the status of humanity proclaimed in Psalm 8 cannot simply be inferred from observations of the natural world—but Ps. 8:3–4 makes that clear! It is not intended as a statement of natural theology but of revelation, and the Christological interpretation of it made in Hebrews 2 points toward the proper way of dealing with the disturbing aspects of nature

which Gould emphasizes. Religion does not derive "ultimate meaning" from scientific data, but if the meaning really is ultimate it should have some place for that data.

Gould's arguments and examples are well stated and, in the irenic spirit which he intends here, should help to take the heat out of some debates between science and religion and to avoid the pitfalls of facile integration. But they will not, and should not, end dialogue between the two magisteria.

Reviewed by George L. Murphy, St. Paul's Episcopal Church, 1361 W. Market St., Akron, OH 44313.

CAN SCIENCE DISPENSE WITH RELIGION? by Mehdi Golshani, ed. Tehran: Institute for Humanities and Cultural Studies, 1998. 205 pages. Hardcover.

"Can science dispense with religion?"—an intriguing question that is answered in brief responses from thirty theistic scholars. The individuals come from a range of disciplines, countries, and religious commitments (six are Muslims and twenty-four are Protestant, Catholic, or Orthodox Christians) making for a diverse collection of ideas. The editor's background in physics and Islam is aptly applied in creating this book whose aim is to "contribute to the illumination of the relation between science and religion" (p. 1).

Each contribution is a response to the following questions:

1. What is your definition of science and religion?
2. Do you see any conflict between your definitions of these two concepts?
3. Where do you think that there may have been a conflict between the two?
4. What have been the grounds for the development of conflict between these two?
5. What has been the role of religion in the development of science in the West?
6. Can we have a religious science?
7. Can science dispense with religion?
8. Can one separate the domains of activity of science and religion completely?

The value of the book lies in the variety of perspectives on science and religion provided by authors of vastly different backgrounds and specialties. Brief biographical vignettes precede each essay, providing a frame of reference that helps in understanding each author's viewpoint. This background provides an appreciation of the similarities and differences between the various contributors and diverts attention from the repetition that necessarily occurs with a collection of this type.

Several articles are particularly valuable in encapsulating profound ideas in succinct statements. For example, "we can't have religious science because religion is accepted freely, unlike science" (p. 82) or that religious science will always mean "... the understanding of religion as some kind of knowledge ... [whereas] the main goal of religion is not knowledge but salvation" (p. 121). The issue of religious science was generally thought to be an oxymoron except for the caveat that a religious scientist "may indeed attain to a far deeper understanding of what science has unearthed than is possible from a profane or secular point of view" (p. 197).

Can Science Dispense with Religion? provides a unique contribution to the dialogue between science and religion. The format provides a meeting-in-print that, like most meetings, contains a mixture of diamonds and stones depending on individual interests. This book is a valuable resource for those teaching in the area of science and religion, since the questions and responses lend themselves to interactive classroom discussions.

Reviewed by Fraser F. Fleming, Associate Professor of Chemistry, Duquesne University, Pittsburgh, PA 15282.

RETHINKING THEOLOGY AND SCIENCE: Six Models for the Current Dialogue by N. H. Gregerson and J. W. Wentzel van Huyssteen, eds. Grand Rapids, MI: Eerdmans Publishing, 1998. 240 pages, index. Paperback; $25.00.

I, as well as most readers of this journal, harbor an interest in both the scientific way of looking at the world and the theological/Christological approach to understanding this same world. Unfortunately, the last several centuries have witnessed many types of intellectual imperialism with various and often extreme positions taken by theologians and scientists alike. This collection of essays attempts to present several defensible models of relating science and theology, especially in light of the postmodernist critique.

The subject matter is not for the casual reader. Some of the contributions are quite dense and theoretical. This is in some sense unavoidable since the

rethinking of the relationship between theology and science must delve into the complex and sometimes murky areas of epistemology, metaphysics, philosophy of science, and philosophy of religion in some fundamental ways. Readers looking for a helpful way to think about some classic evolution/Bible issue, such as how to make sense of physical anthropology and hominid fossils, will need to look elsewhere. These essays attempt to inform how one might make sense of data and theories and ideas from diverse fields of human knowledge.

These leading American and European scientist-theologians move "beyond the work of first-generation thinkers in the field," such as Peacocke, Barbour, and Polkinghorne. Six models are presented: (1) post-foundational epistemology, (2) critical realism, (3) scientific naturalism, (4) non-integrative pragmaticism, (5) complementarity, and (6) contextual coherence theory.

Kees van Kooten Niekerk, Willem Drees, Eberhard Herrmann, and Fraser Watts join the two editors in explicating these varying ways of organizing thinking. I found all the contributors made helpful observations and comments pertinent to the relationship between science and theology, though the six contributions are diverse and often mutually exclusive. One cannot read the book and simply agree with all the points made by each author! In this line, I would have appreciated the authors dealing and debating with a concrete example from the history of the science-theology debate (e.g., the status of the anthropic principle within Christian apologetics or genetic determinism). I found myself attempting to focus the often general and theoretical comments into more practical and thorny "real issues," with only moderate success.

Rather than attempt to summarize or evaluate each of the models, I will focus on the lengthiest and, in my opinion, the most helpful model: Gregersen's contextual coherence theory for the science-theology dialogue. Gregersen, following Nicholas Rescher, points to the criterion of coherence as a critical norm relevant to all forms of knowledge. "Coherence means that different beliefs (or practices) are justified insofar as they are *interconnected* within a logically consistent and substantially comprehensive pattern of thought (or practice)." However, this needs to be balanced with an appreciation of epistemic diversity or the differences in our approaches to reality. Gregersen cites the different descriptions of the nature of water (chemical, biological, fluid dynamic, symbolic, recreational) to differentiate intrinsic from relational properties. Thus, our web of knowledge will have patches of tightly integrated structures (redox chemistry) with looser connections to other areas of knowledge (cell metabolism or sociological theory). No realm of knowledge needs to subsume or reduce other areas but there should be some sort of compatibility or acknowledgment/modification in light of other relevant areas of knowledge. However, science qua science is more tightly integrated and isolated than theology. Thus, theology needs to integrate the natural history of the world and what we know about DNA and personality as part and parcel of its mission, whereas science proceeds quite indifferently to advances or changes in Old Testament hermeneutics. In this sense, the "sciences cannot help but influence the self-understanding of theology; but not so the other way around." The attempt of theology to make a coherent web or map of knowledge is more akin to the classic scientific materialist's attempt to do the same. Both use scientific knowledge to develop a (hopefully) coherent and helpful world view.

Gregersen shows how Resher attempts to distinguish his coherence theory from its rivals in the context of cognitive pluralism. He dismisses skepticism (nothing goes) as self-defeating. Likewise, he contrasts his position with the indifferentism of Rorty's pragmaticism (anything goes). Putman's syncretic (it all goes) is also used as a foil to delineate the fourth and final position, perspectival rationalism. Gregersen illustrates how this model deals with real historical cases of scientific progress/change, such as Priestley's phlogiston theory. He summarizes that the "realist claims are grounded in the fact that the applicative (experimental) and the theoretical cycles have historically reinforced one another. A corroboration by coherence has been achieved."

Gregersen goes on to show how this might provide an alternative to Murphey's recasting of theology as an empirical research program. He shows how a critical incorporation of scientific theories allows theology to grow in its understanding of the world without losing its ability to critique the science or the associated scientific materialist world view of some scientific spokespersons. He compares and contrasts the reaction of various theologians (Henry Drummond, Cardinal Newman, Frederick Temple, Eduard Geismar, Aquinas, Paley, and Peacocke) to evolution in order to show how the contextual coherentist model can inform and guide the construction of our world view or "raft of knowledge." Gregersen is not content with models that do not allow for "any cross-fertilization of perspectives between scientific and religious views of life." The precept "Connect!" aims at more than mere "compatibility," but a "rational competition between different meta-scientific, philosophical or theological

views of reality." Thus, it allows for the fact of cognitive pluralism within a common framework of rationality.

In summary, interested readers will profit greatly from this tome complete with notes and bibliographies for each chapter/contribution.

Reviewed by M. Marcinko Kuehn, 20 Woodward Avenue, Dundas, ON L9H 4J5.

IN SEARCH OF DIVINE REALITY: Science as a Source of Inspiration by Lothar Shäfer. Fayetteville: University of Arkansas Press, 1997. 240 pages, index. Paperback; $26.00.

This fascinating and challenging, albeit very short, book is written by a physical chemist who has been on a lifelong search for evidence, particularly from quantum mechanics, of a transcendent part of physical reality. In just over one hundred pages, the author argues that the insights of quantum mechanics provide the basis for a new covenant between human minds and the mind-like background of the universe. Unlike classical science that took meaning out of life and separated fact from value, findings from the study of quantum phenomena point to a reintegration of these elements. Material things seem to have a nonmaterial basis. The components of real things are not real in the same way that the things they form are real. Local order is affected by nonlocal, faster-than-light, events. Choice and chance play a large part in creating the visible order of things, and observation creates reality. In violation of common sense, and perhaps in opposition to what many would call scientific knowledge, these phenomena describe the transcendental physical reality of the universe.

Shäfer develops his argument by describing what he considers to be the transcendent aspects of knowledge, reality, human nature, and divine reality. By transcendent he means those things that are beyond our control and beyond empirical or rational verification. It is through consciousness, he argues, that we become aware of the transcendent, and it is through our conscious minds that we participate in and communicate with nature. As he states at one point, quoting an unknown source: "The universe is network, not clockwork."

The second half of the book is made up of eighteen small appendices that contain explanations of a number of the scientific and philosophical concepts that the author employs throughout. These include Popper's logic of science, empty atoms as Platonic forms, the nonlocality of the universe, and defining a realistic view of the world. In a discussion of the illegitimate components of knowledge, the author argues that a realistic view of the mind sees it as deeply affected by cultural traditions and operating on epistemic, aesthetic, and ethical principles. The kernel of the author's argument is that the universe as a whole operates on these same principles.

Some readers may object to the rather terse style of this book, but the author states quite clearly that he is presenting his conclusions, and not necessarily the details of formulation, from several decades of thought on these matters. This book should be of particular interest to those who find it difficult to understand how scientists can claim to be both religious and scientific. It should also interest those who are looking for a fairly sophisticated, yet highly readable, example of how scientific principles can help us to understand seemingly nonempirical and nonrational aspects of the universe.

Reviewed by Robert A. Campbell, University College of Cape Breton, Sydney, NS, Canada B1P 6L2.

History of Science

FORBIDDEN ARCHEOLOGY'S IMPACT by Michael A. Cremo. Los Angeles: Bhaktivedanta Book Trust, 1998. 569 pages, bibliography, index. Hardcover; $35.00.

This is an unusual book, possibly an inaugural work of its kind. Cremo's *Forbidden Archeology's Impact* is a compilation of reports, letters, challenging papers, internet messages, and correspondence the author has had with scientists, and his written responses to the multitude of criticisms, which he claims professional journals have refused to print. This book is based on the response to his 1993 work titled *Forbidden Archeology*, a controversial extremist view of human antiquity that literally stunned the scientific community. The book crossed many intellectual and cultural boundaries with the premise that the scientific community has been suppressing knowledge about a full array of beliefs to include creationist ideas and a plenitude of conspiracies.

Criticism of Cremo's work, both the original volume and this follow-on chronicle, runs the gamut of a "cornucopia of dreck" to the other end of the spectrum where some claimed that the books were "the landmark intellectual achievements of the late 20th

century." Foreword writer, Colin Wilson, claims that *Forbidden Archeology* "is simply an extremely erudite and extremely amusing account of what might be called the other side of the post Darwinist story." The vast array of opinions on the original work makes the second book all that more interesting, for Cremo responds to each one in a definitive, albeit, somewhat disorganized, manner.

Cremo is an author and researcher specializing in the history and philosophy of science. His persistent investigation during the eight years of writing *Forbidden Archeology* documented a major scientific cover-up, making him a world authority on archeology anomalies regarding human antiquity. In 1996 an NBC-TV special, *The Mysterious Origins of Man*, hosted by Charleston Heston, featured Cremo's original work which exposed the scientific world to a series of conspiratorial allegations.

By Cremo's admission, "the problem with the scientific method is that it is driven far too much by theory, and not enough by fact. By which I mean that science moves forward by the development, and subsequent testing, of hypotheses, when at times formation of hypotheses should be strenuously avoided because they grow into filters which taint otherwise vital and compelling data." What this book does is document the explosive reactions to Cremo's assertions. It also continues to ignore conventional archeological wisdom by claiming that "science is not comfortable with unknowns." So, rather than leave a question unanswered (e.g., "How old is humankind?"), Cremo attempts to tackle head on what many scientists refuse to ponder. In both books, there is no doubt that Cremo has the courage not to ignore data which "flies in the face of accepted scientific wisdom."

To offer an opinion of this book requires exploring the intent of the original work. However, since both works are separate in construct, Cremo's newest book is nothing short of a menagerie of disjointed letters and reports. The author obviously had no intention of intertwining these textual elements into a cohesive woof, so readers should not expect the book to develop any central argument.

The curious reader may find *Forbidden Archeology's Impact* worthwhile, if for no other reason than to see how an author may defend a fairly unpopular thesis. While this book is long and laborious at times, it provides enough information to stimulate further study of his original work.

Reviewed by Major Dominic J. Caraccilo, 1212 Whisperwood Drive, Columbus, GA 31907.

DEBATING DARWIN: Adventures of a Scholar by John C. Greene. Claremont, CA: Regina Books, 1999. 289 pages. Hardcover; $34.95.

Greene, History Emeritus Professor at the University of Connecticut (Storrs), is one of the foremost experts in the history of evolutionary thought. His *The Death of Adam: Evolution and Its Impact on Western Thought* (1959) and *Darwin and the Modern World View* (1961) are now classic studies of the influence of Darwin on Western intellectual life. *Debating Darwin* is an autobiographical retrospective of Greene's distinguished career in which he explores Darwinism both as a successful scientific theory and as a world view that served essentially as a religious and philosophical faith.

Greene, an Episcopalian, rejects the notion that scientific explanations are total explanations and that nature as known to science exhausts reality. In particular, he finds the efforts of leading Darwinists to derive knowledge of human duty and destiny from evolutionary biology unconvincing. Moreover, his rhetorical analysis of leading evolutionary thinkers' works indicates that they have resisted the notion of a purposeless world stripped of meaning and value, despite the logic of neo-Darwinistic positivism. Predictably, Greene's views were not always received with enthusiasm, but they did bring him into extended correspondence with two of the towering figures in twentieth-century Darwinian thought: Theodosius Dobzhansky and Ernst Mayr. One of the great virtues of *Debating Darwin* is the reprinting of a good deal of this correspondence (some, but not all, of it published elsewhere) along with essays which provide the context for the exchanges.

Greene's correspondence with the Harvard evolutionary biologist (ornithologist) Mayr began in 1979 and continued into the late 1990s. It is supplemented in *Debating Darwin* with several chapters of Greene's analysis of Mayr's evolutionary philosophy. The Greene-Mayr exchanges are certainly interesting, but reveal that the world views of Mayr, an atheist, and Greene are so different that it is difficult for them to find substantive common ground. Mayr cannot fathom how anyone who really understands the theory of evolution could be a theist. Most scientists, Mayr contends, are like himself, deeply religious people, but see no need for theological dogma based upon some divine revelation.

While Greene's dialogue with Mayr dominates the book, his correspondence with the Columbia University geneticist Dobzhansky is far more interesting, no doubt because they share the same theistic assumptions. The two began corresponding in

December 1959, following the Darwin centennial celebration at the University of Chicago, and continued until the summer of 1962. Their correspondence focuses on Greene's assertion of the religious role of metaphor in evolutionary biology. Greene contends that Dobzhansky and other leading Darwinians illegitimately use teleological and vitalistic figures of speech in describing the evolutionary process they hold to be mechanistic, blind, and purposeless. He suggests that the evolutionary literature is full of words and figures of speech smuggled into the discourse—like "progress," "improvement," "higher," and "advance"—that clearly suggest striving, purpose, and achievement. The exchanges with Dobzhansky reveal a fault-line that still divides many Christian intellectuals today. Dobzhansky noted quite perceptively that for Greene "evolution is something unwelcome though unavoidable," but for himself "evolution is a bright light" (p. 99).

Debating Darwin is extremely interesting intellectual history and autobiography. While its organization is at times challenging—with frequent citations from some of Greene's previously published essays interspersed with current commentary, sections of the book are riveting. *Debating Darwin* illustrates the value of a historian's sustained examination of the world view implications of modern science. Throughout his career, Greene has voiced unpopular ideas within the academy about a scientific world view that has functioned as a secular faith. Without calling into question the "methodological naturalism" of science or advocating anything like a "theistic science," he has exposed the philosophical pretensions of leading Darwinians.

Reviewed by Donald A. Yerxa, Professor of History, Eastern Nazarene College, Quincy, MA 02170.

Natural Science

MESSAGES FROM AN OWL by Max R. Terman. Princeton, NJ: Princeton University Press, 1997. 233 pages + xii. Paperback.

This book has an important message from a fastidious observer of owls: Science is more than technology. Technology is only one tool of the scientist. Contemporary students, dazzled by high tech gene transfer, humming laboratories, chromosome painting, GIS methods, and a plethora of other techniques—all wonderful in themselves—seldom think of Darwin's voyage on the *Beagle* as a scientific process. We usually use the phrase *the* scientific method—hypothesis, experimentation, etc. Is this what Darwin used? No. Much of science is careful observation—a trait we need to develop early on in the training of young scientists. This book deals with careful observation as well as experimentation using such modern techniques as radio telemetry.

Terman, biology professor at a small Christian college, rescues a great horned owl and develops a remarkable friendship with the animal over a period of several years. The human-animal interface is perhaps the thing I found most fascinating about the story of Stripey the owl. Can humans communicate with owls? Is the young bird deleteriously imprinted by contact (I almost said fellowship) with humans? Will the bird allow a human friend access to its home? Does Stripey have a family? For answers to these and more, read the book and the surprise ending!

When I first read the book, I was annoyed by what I thought were unnecessary digressions about problems in the author's life. Then I realized that consciously or unconsciously, the author was chronicling his life parallel to that of the owl. We, the readers, are observing him in the cycles of the academic year, family concerns, and professional growth. These are some of the "basic themes of life" Terman refers to in the preface.

It is obvious that the author loves Stripey. As a result, we are presented with page after page of poor quality photographs, rather like proud grandparents who understand their offspring more than their camera.

Anyone interested in careful research and the simple joy of reading about animals will find this book delightful. It shows how real science can be done in the fencerows and fields of Kansas and, by extension, in our own backyard.

Reviewed by Lytton John Musselman, Mary Payne Hogan Professor of Botany, Old Dominion University, Norfolk, VA 23529-0266.

ROMANCING THE UNIVERSE: Theology, Science, and Cosmology by Jeffrey G. Sobosan. Grand Rapids, MI: Eerdmans Publishing Company, 1999. 212 pages, notes, bibliography, and index. Paperback; $16.00.

Sobosan is professor of theology at the University of Portland, Oregon. He has written several books including *The Ascent to God, Bless the Beasts,* and *The*

Turn of the Millennium: An Agenda for Christian Religion in an Age of Science. The last title provided some of the materials in the book under present review.

This book describes the author's admiration of the universe as revealed by astrophysics. It is also a reflection of the author's appreciation of science. Sobosan marvels at the beauty of the stars in the night sky and the fascinating explanation of their formation. In addition to his observations of nature and comprehension of scientific theories, he discusses some theological aspects of cosmology. He believes that, while Christian theology has intensely depended upon philosophy for its doctrines, now is the time to depend similarly on contemporary sciences. He argues that there should be a union between theology and science, and theology must first establish this union.

Sobosan is well read on contemporary sciences and cosmology, as evidenced by the numerous references in these fields cited in *Romancing the Universe*. However, the sciences under discussion in this book are predominantly astronomy and physics. Biology and chemistry are rarely mentioned.

Sobosan brings up an interesting issue of applying the indeterminacy notion in quantum theory to the macroscopic world. He then refers to a belief that all things in this universe are somehow interconnected with one another, and so influences are reciprocal. Sobosan mentions two hypothetical examples: (1) plucking a flower might trouble a star; and (2) the flapping of a butterfly's wings in Bolivia might produce a windstorm in New York. This belief sounds like part of Buddhist teachings on wisdom and resembles the holistic concept in Eastern philosophy.

Though the author writes in plain English, some parts of the text are hard to follow. Sentences over fifty words are common. One sentence has 103 words! To understand such lengthy sentences, one must read them repeatedly. Thus, one can easily lose the main point of the discussion. In addition, double negatives abound throughout the book. The main text is only 154 pages long, yet there are 215 endnotes, most of which are as long as a paragraph. Those numerous and lengthy endnotes, though expository, are quite distracting.

Reviewed by James Wing, 15107 Interlachen Drive, Unit 1014, Silver Spring, MD 20906.

Origins

A NEW LOOK AT AN OLD EARTH by Don Stoner. Eugene, OR: Harvest House Publishers, 1997. 256 pages. Paperback; $10.99.

Stoner earned a B.S. in physics, was involved with the development of the optical disc, and holds two U.S. patents. His grandfather, Peter W. Stoner, was chairman of the natural science division at Westmont College, a charter member of the American Scientific Affiliation, and an elder in the Presbyterian Church. His parents were engineers who both worked on the Manhattan Project.

Many ASA members have read Peter Stoner's book, *Science Speaks* (Van Kampen Press, 1952; Moody Press, 1963 and 1969). It is relevant to compare Don's book with his grandfather's. The elder Stoner apologized to fellow Christians on behalf of scientists. He acknowledged that the Bible had been under attack from the natural sciences, but he showed that more recent findings (especially in astronomy) tended to agree with biblical teachings about the universe. Therefore, science was not the enemy of faith, as many had suspected. In contrast, the younger Stoner is calling his fellow Christians to apologize to scientists. Since science properly understood cannot conflict with the Bible rightly interpreted, religious people must stop treating scientists as enemies.

In the foreword, Hugh Ross emphasizes both the reality of a science-religion conflict and the need to end it. Young-earth creationism, says Ross, has been a stumbling block for believers and nonbelievers. It has brought divisions among Christians; it has made secular society more skeptical of the church; and it has provided ammunition for those who seek to delete all biblical references from public education.

I appreciate Stoner's call to humility in Chapter 1, which is entitled "Judging Ourselves First." He reminds us that we often remember biblical details incorrectly. Worse, we cannot always be sure what Bible words meant in the original languages. For example, the Hebrew terms rendered *day* and *die* in Gen. 2:16–17 could each be taken several different ways. The most literal interpretation, that Eve would drop dead the day she ate the fruit, is contradicted by subsequent verses. Stoner would resolve this dilemma by translating *yom* as *era* (thus, Eve's sin ushered in an era of human mortality). I do not share his interpretation of Genesis 2; nevertheless, I admire his apt illustration of the difficulties of trans-

lating Hebrew and the potential pitfalls of strict literalism. Stoner concludes that young-earth adherents need to reevaluate their interpretation of Scripture. He urges them to get rid of faulty assumptions and wrong attitudes:

> ... it is difficult for those who are not scientifically educated to tell the difference between scientific truth and error ... Juicy claims about how some Ph.D. has misread the facts are circulated from Christian to Christian just like gossip ... Unfortunately, we might never bother to find out if any of these stories are true ... we have been mocking educated men and, what is worse, we have done it from a position of ignorance.

Chapter 2, "Science, Theology and Truth," emphasizes that *scientist* is not the antonym of *Christian*. Indeed, Stoner says, science has much in common with religion. Scientists use a set of rules to discover truth from nature; theologians follow another set of rules to discover truth from the Bible. Both groups need to exercise faith; both need to be skeptical of their own theories; both are fallible. Just because scientists claim that something is true does not mean Christians have to believe the opposite.

In Chapter 3, "The Present-Day Stumbling Block," Stoner summarizes and refutes eight arguments for interpreting *yom* literally. He concludes that there are no compelling theological or hermeneutical reasons why Genesis must be taken as a chronology of consecutive 24-hour days.

Chapter 4, "A Shadow of Eternity," argues that the universe *must* be billions of years old if we can observe galaxies that are billions of light-years distant. Stoner rebuts young-earth claims that (1) stars are much closer and smaller than astronomers think they are; (2) the speed of light has decreased; and (3) God created the stars with light already in transit to make them appear older than they really are.

Chapter 5, "The Testimony of Many Witnesses," explains several evidences for antiquity, including tree rings, stratigraphy, lunar soil, and radiometric dating. It also critiques thirteen scientific arguments for a young earth, including geomagnetism, polystrate fossils, and alleged fossil human tracks in the Paluxy River.

Chapter 6 traces the origins of modern scientific creationism to Seventh-Day Adventist theology and the flood geology of George McCready Price. I do not understand Stoner's rationale for including this discussion. He seems to imply that his readers should reject the young-earth view because of the religious tradition in which it arose. This runs counter to his teaching in chapter two: we should discard the young-earth model because there is overwhelming scientific evidence against it, *not* because groups we disagree with happen to embrace it.

In Chapter 7, Stoner argues that we can read Genesis 1 in a way that is consistent with current cosmological theories. His concordism is similar to one given by his grandfather in *Science Speaks*. In his model, Gen. 1:1 describes the Big Bang; Gen. 1:2 refers to a dark nebula; Gen. 1:3 records stellar formation; Gen. 1:4 suggests the clearing of interplanetary dust by solar wind; etc. Stoner's interpretation of the creation narrative is very interesting, and it *might* be correct. But, like any other theory, his needs to be held tentatively at the fingertips so that a gentle breeze of fact can dislodge it easily. The danger with a concordism is that our religious message may be doubted if the scientific details with which we link it are some day discredited. According to Stoner, this is precisely what has already happened with the young-earth paradigm. The current old-earth model *may* be right, but we need to tread lightly, as all scientists and theologians should do.

Stoner says in Chapter 2 that one of his purposes in writing *A New Look at an Old Earth* was to prepare Christians to lead scientists to Christ. I commend him for that goal, but his statement troubles me for two reasons. First, this book alone cannot accomplish the goal. If Stoner convinces his readers to abandon the young-earth model, that will at least remove a stumbling block, but more is necessary. Christian nonscientists will need to become liberally educated in the sciences if they expect to win the confidence of nonbelieving scientists. They will also need to study the Bible and be trained in effective techniques of evangelism. Second, I have long assumed that Christians in scientific professions (e.g., ASA members) were in a better position to witness to their unsaved colleagues than nonscientists would be. If God raises up nonscientists to win scientists, perhaps it means we have neglected our opportunities.

Every ASA member should read *A New Look at an Old Earth*. Most of us do not need to be convinced that the earth is old, but all of us need to hear Stoner's plea for humility. Buy a copy for your church's library; discuss it in your adult Sunday school class. Please share this book gently in Christian love with any brothers and sisters who still adhere to young-earth views.

Reviewed by Joseph Lechner, Professor of Chemistry, Mount Vernon Nazarene College, Mount Vernon, OH 43050.

ORIGINS: Cosmos, Earth, and Mankind by Dominique Simonnet, et. al. Los Angeles: Bhaktivedanta Book Trust, 1998. 569 pages, bibliography, index. Hardcover; $35.00.

As advertised, this book is a primer to modern science's answers to some very basic questions about the origins of the solar system and the evolution of our Earth. General readers and undergraduate students get a painless introduction to modern science's answers to basic questions about the origins of the universe, life on Earth, and evolution of humankind. This book is cleverly organized into a question-answer based format that offers a third person narrative asking the questions that lead to a response by one of three subject-matter experts.

The unintimidating questioner is deputy editor-in-chief of the weekly magazine *L'Express*, Dominique Simonnet. Throughout this three act (nine scene) book, Simonnet poses questions to the cast: Hubert Reeves, an astrophysicist professor at the University of Montreal; Joel De Rosney, an organic chemist who was formerly the director of the famed Pasteur Institute and currently directs the City of Science in Paris; and Yves Coppens, an anthropologist and professor at the College de France who co-discovered Lucy. Topics for these acclaimed scientists include the big bang theory, the chemistry of DNA, the four fundamental physical forces, and various discoveries of hominid fossils.

"What this book intends is to describe, in easily understandable terms, [the] history of the universe and the world, relying on the latest scientific knowledge." The three acts—the cosmos, life, and humankind—cover roughly fifteen billion years, the estimated time of the universe's existence.

Reeves leads off by offering a prescription for the story of cosmology from the formation of the basic building blocks of matter in the era after the Big Bang to the convergence of our planets around our sun. Assisting us to understand the vastness of the universe in which we live, Reeves helps the reader to understand that "whenever you focus your telescope on any given region of the universe, what you're really doing is observing a moment of its history." Brimming full with laymen's examples, this act sets the stage well for the rest of the book.

After understanding what makes our planet different from the others in the solar system, De Rosnay then examines how the conditions that existed on primitive Earth gave rise to life as we know it today. One of the biggest lessons offered by De Rosnay is that "life does not evolve spontaneously, it took a very long time for it to appear." Even more so, De Rosnay explores the three "solutions" which explain the initial manifestations of life: divine intervention, chance, and an extraterrestrial mean.

Finally, Coppens concludes that "the evolution of the universe, like that of life, has been, to say the least, chaotic." In the final act, he recapitulates the now familiar African origin of hominids, their gradual development into our human ancestors, their invention of technology, and their spread throughout the world. Realizing that "Africa could be the cradle of the human race," and framed by a series of droughts, Coppens tells us that humankind has evolved to what it is today.

This leads us to the final question posed by Simonnet in the closing chapters: "How would you characterize this next act?" In response, De Rosnay offers that the future of humankind will embody the "cultural evolution," where "we are constantly improving the mastery of our body and of our environment." In the end, *Origins* is a great handbook that defines how the universe evolved, and how the future will most likely unfold. It continuously reminds us that "we are but a flickering spark in the overall context of the universe."

Reviewed by Major Dominic J. Caraccilo, 1212 Whisperwood Drive, Columbus, GA 31907.

Philosophy & Theology

MEANS TO MESSAGE: A Treatise on Truth by Stanley L. Jaki. Grand Rapids, MI: Eerdmans, 1999. 233 pages. Paperback; $22.00.

Jaki, Distinguished Professor at Seton Hall University, is one of the twentieth century's most prolific historians and philosophers of science. He has earned doctorates in both theology and physics, written nearly forty books, made an honorary member of the Pontifical Academy of Science, and was the recipient of the Lecomte du Nouy Prize for 1970 and the Templeton Prize for 1987. His work is not easily categorized. Although he is a staunch foe of scientism, Jaki avoids identification with some of the more parochial evangelical Christian responses to matters of evolution, design, and teleology. In this provocative essay, Jaki vigorously defends realist epistemology and the importance of metaphysics. In the process, he presents a sustained critique of "the baneful influence of science on philosophy."

Jaki begins by asserting that a philosopher must rely upon the reality of the means used to convey any philosophical message. The means—usually a book, but not necessarily so—is something tangible, real. And the use of any means "obligates the philosopher to recognize the objective truth of means, so many objects." Rational discourse must begin with the reality of objects. Any attempt to deny the reality of the means (that is, objects) leads to all sorts of epistemological "sleights of hand" which have marked the Western philosophical tradition, especially since Kant. The rest of the book is an extended investigation of the implications of the philosophical priority of the means over the message, which prompts Jaki to discuss a wide range of topics, often with devastating clarity: free will, purpose, causality, change, the mind, the universe, ethics, God, history, and miracles.

While it is a philosophical treatise, *Means to Message* will be of particular interest to scientists. Jaki minces no words: "Philosophy is in the process of being swallowed up by science, or what is just as disastrous, philosophy is being confused with the discourse of nonscientists who ape science." Science should not be done as a form of philosophy, Jaki argues. We ought not rush to science to gain our philosophical insights, especially since science is unable to account for the reality of the means that bears its messages. A controversial example is twentieth-century theoretical physics, which, Jaki contends, has constructed an edifice of quantitative ideas and beautiful mathematical propositions unable to provide "the very material, tangible physical reality, on which its equations are supposed to work." One might well challenge Jaki's characterization of theoretical physics as reductionistic, but he is correct to note that science dominates contemporary cultural discourse. Senior scientists who lack the clarity of sophisticated philosophical reasoning are increasingly lionized as important philosophical voices. And popularizers recklessly ransack science to put a "scientific veneer" on patently nonscientific claims ranging from uncertainty to the nature of the cosmos. We live in a culture where "scientific packaging" dominates serious discourse.

Another example is the philosophical myopia evidenced by the acceptance of the view that a purposeless evolutionary process could produce a being whose very nature is to act for a purpose. Jaki is not taking on evolution per se, but the unjustified ideology of evolutionism, based on the "miscegenation of chance and necessity." Chance, Jaki contends, is a "glorious cover-up for ignorance," and necessity is "refuted by the very freedom whereby it is posited." Jaki finds it duplicitous to argue for necessity and purposelessness in books freely written for a purpose.

Many readers will no doubt take exception to some of Jaki's bold assertions, not the least of which is his relegation of science to the magisterium of the measurable. Yet rare indeed will be the reader who does not gain from a careful examination of this book. With so many in the science and theology field recasting the historic doctrines of Christianity to comport with the current scientific thinking in ways often unrecognizable, Jaki remains a strong voice of caution. *Means to Message* is recommended both as a great introduction to Jaki's substantial work and a noteworthy philosophical essay on the limits of science in an age of science.

Reviewed by Donald A. Yerxa, Professor of History, Eastern Nazarene College, Quincy, MA 02170.

TWILIGHT OF THE CLOCKWORK GOD: Conversations on Science and Spirituality at the End of an Age by John David Ebert. Tulsa, OK: Council Oak Books, 1999. 211 pages. Hardcover; $22.95.

Ebert's premise for *Twilight of the Clockwork God: Conversations on Science and Spirituality at the End of an Age* revolves around establishing that our *predictable* world, a world where science and laws dictate the outcome, is quickly becoming obsolete. This clockwork god is the deity who, in Isaac Newton's universe, set the great celestial clock in motion and then walked away to let natural law take over daily regulation of the spheres. "The transformation of scientific theories into mythic analogs will create a more affective language for science ... what religion can borrow from science, on the other hand, is new *knowledge* about the universe that, in turn, can transform through the mythic imagination."

Using a series of interviews as a venue for conveying his complex, but thoroughly complete, thesis, Ebert resoundingly supports his premise that the world view of materialism is currently undergoing transformation into a more spiritually informed way of regarding the cosmos. The interview style helps keep the reader from becoming lost in unfamiliar and advanced theory-based ideas and helps us to understand the many players involved in supporting his propositions.

Ebert has been an editor with the Joseph Campbell Foundation for six years. A graduate of Arizona State University, he is a recognized authority on the relevance of mythology to contemporary society,

especially that of myth to science. He has written and spoken extensively on these subjects in national journals, reviews, and public speaking tours. Ebert has appeared as the expert on mythology numerous times on A&E Channel's *Ancient Mysteries*.

"According to this neat but limited understanding, religion worshiped the clockmaker god, whereas science examined the clock." This clockwork god should have been put to rest and "yet we continue to maintain faith in the absolute power of our scientific knowledge and believe, that, in the end, more technology will resolve the problems that surround us." That is why this book is so important. As stated in the forward by F. David Peat: "it argues powerfully for the new vision of nature, and ourselves, that emerged in this century." This "new" type of thinking is not monolithically hierarchical; rather it is a fusion of two of the most powerful spheres related to humankind: science and religion.

An intriguing book, with interviews from Brian Swimme, Deepak Chopra, William Irwin Thompson, Rupert Sheldrake, Ralph Abraham, Lynn Margulis, Terrance McKenna, and Stansilov Grof, *Twilight of the Clockwork God* is clearly a multidisciplinary approach in support of Ebert's theory that there is a distinct relationship between the imagery shared by archaic myth and contemporary science. Drawing from this new generation of scientists, all of whom extrapolate great inspiration from mythology in their scientific practice, Ebert masterfully illustrates their place in the history and development of Western thought.

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SCIENCE WITHOUT LAWS by Ronald N. Giere. Chicago: University of Chicago Press, 1999. 241 pages, endnotes, index. Paperback; $25.00.

Giere, a philosopher of science who originally trained as a physicist, advocates a multidisciplinary perspective on science that avoids the excesses of either extreme relativism or extreme essentialism. Through the essays collected in this volume—all but one have been published elsewhere—Giere attempts to demonstrate that we can have realism without truth, and scientific judgment without rationality. He begins from the position that there is genuine scientific knowledge that has accumulated, especially over the last century. However, he argues that trouble arises when we assume that the same world view, within which we were able to develop successful scientific theories, provides a firm foundation for theories about science. The idealism and universalism of the Enlightenment project, both of which have been institutionalized in science and the philosophy of science, prevent us from developing theories of science that reflect actual scientific practice. For Giere, notions of scientific truth, scientific rationality, and laws of nature largely based on theological imperatives only serve to misdirect our efforts to understand science.

Giere advocates a naturalistic approach to the study of science that is characterized by a focus on practice, rather than trying to explain science on the basis of some supernatural or nonempirical system, no matter how logically consistent such a system might be. Giere also argues that models are the primary representational entities of science, and that, in practice, scientists are concerned with the goodness of fit between their models and the world around them. In several places, Giere uses the example of the pendulum, or simple harmonic oscillator, to illustrate the effectiveness of models.

The idea that there can be realism without truth is based on the idea that conceptually what is meant by realism is whatever our best representations of the world can provide. In other words, realism has to do with the fit between a model and the real world, and the fit will always be partial and imperfect. Any notion of truth in this respect is reserved for discussions of the internal characteristics of the model itself. Similarly, when Giere argues that we can have scientific judgments without rationality, he is not implying that scientific judgments are irrational, but that they are not rational in some formal or strictly logical sense. Instead, they reflect an instrumental rationality that will be based on a multitude of cultural, social, and practical factors.

The book is divided into three sections, and the essays are arranged according to their difficulty and to their intended audience. The first section is intended for a general readership of scientists, historians, philosophers, and sociologists of science, as well as undergraduate students in these areas. The middle section is directed at those scholars involved more directly in science studies, and the language and examples used by the author reflect ongoing debates in this field. The final section is intended for philosophers of science and as with the essays in the middle section, the form and content of the author's arguments reflect the norms of the discipline. Most chapters serve to develop Giere's naturalistic approach to science and the majority contain an illustration of some successful model. The final two chapters, however, one on the history of logical em-

piricism and a very brief one on the concept of underdetermination, appear to be random add-ons that do little to advance the author's position.

From my perspective, the major problem with this book is that it is highly repetitive. I was unable to determine how the work as a whole advanced my understanding of Giere's position beyond what I could glean from any one of the individual essays. In fact, for those readers interested in the details of Giere's position, I would recommend his 1988 book, *Explaining Science.*

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CULTURAL BOUNDARIES OF SCIENCE: Credibility on the Line by Thomas F. Gieryn. Chicago: University of Chicago Press, 1999. 398 pages, index. Paperback; $21.00.

Gieryn has for many years been in the thick of the debates about the nature of science and the boundary between science and nonscience. His earlier books have argued for a sociological construction view of science. He does not fall, however, into the trap of a reductionist subjectivism that sees science as only a socially constructed view of the world. That is, he believes that science does provide real information about the real world rather than just an ontological reality of our own making (e.g., Von Glassersfeld). His earlier edited work, *Theories of Science in Society*, sketched out a number of ways in which societal beliefs, mores, and institutions shape the direction, scope, and growth of science.

This work concentrates on the cultural boundaries that distinguish science from nonscience. Typically, demarcation arguments have focused on the more objective methods of the sciences versus other fields of human endeavor, the power of peer review, the creative use of technologies, and elaborate theoretical (explanatory) constructs to account for disparate empirical data. Gieryn argues that the credibility of science arises not from these essentially internal features but from cultural authority in the form of "cultural maps" that people use to decide whom to believe. He argues rightly—in this reviewer's mind—that there are no fixed criteria whereby science can be demarcated from nonscience. Science is a pliable cultural space within human belief systems that at different points in time has exhibited markedly different responses to such artifacts as phrenology, cold fusion, various social science theories, and "organic" medicine and agriculture.

A series of specific and highly diverse case studies are used to illustrate his points and forge the essential argument. The first chapter looks at John Tyndall's double boundary-work exploring science, religion, and mechanics in Victorian England. The second chapter takes up the struggles of the U.S. Congress to demarcate natural science and social science beginning with the Office of Scientific Research and Development (OSRD) in the 1940s through issues surrounding the social sciences within the National Science Foundation. The third vignette looks at the competition for appointment to the Chair of Logic and Metaphysics at the University of Edinburgh in 1836 between the phrenologist George Combe of Edinburgh and the Oxford-trained philosopher from the Scottish Common Sense school, Sir William Hamilton. Next he takes up the story of cold fusion at the University of Utah, focusing especially on the media's role in shaping perceptions and understandings about the legitimacy of the claims being advanced. His final case concerns Albert and Gabrielle Howard and the fusion of composting, science, sociology, and culture. His concluding chapter provides fresh insights into the current science culture wars, including public debates within and outside science about "creation" and "evolution." This is a useful book to obtain, read, discuss, and mull over in light of whatever new theories in the name of science are advanced.

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BAKER ENCYCLOPEDIA OF CHRISTIAN APOLOGETICS by Norman Geisler. Grand Rapids, MI: Baker Books, 1999. 841 pages. Paperback; $49.99.

Geisler serves as dean and professor at Southern Evangelical Seminary. His books, mostly in the area of apologetics, include *Christian Apologetics, When Skeptics Ask,* and *Answering Islam.* This book is addressed to a wide audience and includes all Christians who encounter skeptics or are dealing with their own skepticism. It is intended to provide extensive coverage of philosophical systems, contemporary issues, difficult biblical passages, and apologetic concepts.

Apologetics is a rational defense of the Christian faith, and Geisler strives to provide appropriate and reasonable responses to critics of Christianity. The classic charges and questions against Christianity are presented along with possible answers. Accord-

ing to the publisher, this book "stands as the culmination of the author's lifelong career and ministry." It contains an extensive bibliography as well as Scripture and article indices. The alphabetical listing of the articles makes the information easy to locate. Topics discussed include creation, Darwin, determinism, the problem of evil, evolution, and science and the Bible.

Reviewed by Richard Ruble, John Brown University, Siloam Springs, AR 72761.

THE SHAPING OF RATIONALITY by J. Wentzel van Huyssteen. Grand Rapids, MI: Eerdmans Publishing, 1999. 303 pages, index. Hardcover; $35.00.

Van Huyssteen is a Professor of Theology and Science at Princeton Theological Seminary. He is the author of two other books and numerous papers on theology and science. In this book, van Huyssteen discusses the nature of human rationality, and how it can successfully bridge varied domains of life (e.g., science and theology). The view that we have inherited from modernity is that the impressive performances of the hard sciences stand in stark contrast to the relative irrationality of religion. But the real issue between science and religion has not been one of propositions, but rather of power—claims to authority. Both science and religion, however, now find themselves challenged by postmodernism's irrationalism. We must not let rationality slip away or we will lose that which gives us our uniqueness as human beings.

The first chapter explores the nature of postmodernism. Postmodernism challenges science's claims of objectivity. For example, scientists compete subjectively for the acceptance of their individual results and theories. The direction of scientific research is influenced by the politically driven distribution of research funds. The list goes on and on. Though on the surface it appears that postmodernism improves the relationship between science and theology by blurring disciplinary boundaries, postmodernism actually challenges rationality and thus removes any possibility for science and theology to relate to one another.

Chapter two focuses on nonfoundationalism as an important root of postmodernism. Modernism's foundationalism claims that knowledge rests on a few self-evident facts. Postmodernism's nonfoundationalism claims there are no fundamental bases of truth. Nonfoundationalism is devastating to the attempt to relate science and theology because it removes any possibility for common ground. But foundationalist scientists and theologians have disagreed on the foundations of knowledge, which has also removed any possibility of dialogue. Van Huyssteen argues for what he calls postfoundationalism. Theological and scientific truth claims must be viewed as fallible and provisional but rationality provides the common ground on which science and theology can meet. This trust in human rationality is distinctly modernist.

Chapter three details postfoundationalism. Postfoundationalism avoids postmodernism's nonfoundationalism, and also avoids modernism's claim for a single unified knowledge—a "splitting of the difference" between modernism and postmodernism. The classical notion of rationality has been decidedly scientific in its emphasis on universality and its lack of emphasis on values. Van Huyssteen calls for a broader model of rationality that includes problem-solving ability and an awareness of experience and social surroundings. This model of rationality can be applied equally well to science, theology, and their relationship.

Chapter four shows how the richness of human rationality reaches both science and theology, and thus can be used to break down the traditional modernist separation between the two. Scientific knowledge differs from religious knowledge only in degree. Science and theology offer complementary interpretations of our experience. The common evangelical belief that commitment precedes religious understanding is a form of fideism that erects a barrier between science and theology. The view that science and religion are complementary, because science answers "how" questions while religion answers "why" questions, results in the privatization of religion. Science and religion differ in many ways but they share the same rationality.

Chapter five argues that the dialogue between science and religion begins with opinions and values. Theology, like science, does not have a single focus or overriding concern that defines its current image. Theology and science need to deal with this fragmentation by avoiding the arrogance of prescribing foundationalist rules for interdisciplinary dialogue. Both sides must accept the fact that others will not only differ, but that it may be perfectly rational for them to do so. Both sides must embrace intellectual honesty, which will be different for each person because of varying experiences and traditions. However, this postfoundationalism escapes relativism by claiming that rationality is only conditioned (rather than determined) by context.

This treatise is an in-depth treatment by an eminent scholar. It has over 150 bibliographic references, and I came away with the impression that it was written more for the specialist than the layperson. The author makes no attempt to communicate in an easily accessible style or vocabulary. There are other books on the topic that are less difficult, but for those willing to put some work into it, this book is full of subtle yet crucial themes on the relationship between science and theology.

Reviewed by Dan Simon, Assistant Professor of Electrical Engineering, Cleveland State University, Cleveland, OH 44115.

Social Science

UNHOLY MADNESS: The Church's Surrender to Psychiatry by Seth Farber. Downers Grove, IL: InterVarsity Press, 1999. 162 pages. Paperback.

"Get some counseling," the Bible teacher told the woman in her group who was suffering in an abusive marriage. "Talk to a counselor," was the advice of the pastor of a church where a member was involved in molesting a child of another family in the same congregation. "You might be depressed, maybe it's a chemical imbalance," we told our friend. "Have you considered counseling?" Does this sound familiar? According to the author of *Unholy Madness*, it is all too familiar.

In this well-written book, Farber contends that the church should be more involved in caring for those with emotional problems, an argument posited by other writers such as Larry Crabb. But this book goes far beyond urging that professional counselors be replaced by caring elders. Farber follows the radical psychiatrists, Thomas Szasz and R. D. Laing, who contend that there is really no such thing as mental illness. With a changed paradigm, care for people diagnosed as mentally ill could be handled in the church, Farber reasons, if the church were more countercultural and more egalitarian.

He writes of the damage caused by Augustinian theology. Because Augustine believed strongly in the sovereignty of God, humans were not encouraged to realize their God-given potential. What is needed, he stresses, is a true humanism, not "the misanthropic Augustinian anthropology that has pervaded Christianity for centuries."

Christianity as the official religion of the Roman Empire also has had a deleterious effect on the church. By becoming part of the culture and losing its countercultural stance, the church became irrelevant. Unlike the anti-Augustinian stance, other authors (most recently, Cal Thomas and Ed Dobson in *Blinded by Might*) have suggested that the most effective way for the church to influence society and culture is by being the church. This means a concern for programs and organization.

Unholy Madness is a thought-provoking book. I am not a counselor or a psychiatrist, but I find it hard to accept that there is no such thing as true mental illness. I heartily agree that we live in a society obsessed by therapy. And I agree that the church turns too quickly to therapy rather than searching for spiritual meanings in the experiences of those put into the "mental illness" category. But I find Farber's polemic against mental illness a bit extreme. When I discussed the book with a practicing Christian psychologist, he said that his experience convinces him that mental illness does indeed exist. Whether or not you agree, I recommend this book to anyone concerned with the psychiatric industry and its relationship to the church and society.

Reviewed by Lytton John Musselman, Mary Payne Hogan Professor of Botany, Old Dominion University, Norfolk, VA 23529-0266.

Letters

McIntyre's Fatal Flaw

The moment I read the title of McIntyre's article, "Evolution's Fatal Flaw" (*PSCF* 51 [September 1999]: 162–9), I suspected that I would not like it. As I read on, my suspicions were confirmed. The idea that evolution as a science could have a problem as pathological as a "fatal flaw" without somehow having been detected during the last century of rigorous scientific inquiry is absurd.

McIntyre specifically claims that his article addresses a flaw at "the heart of the theory of evolution" and the "understanding of evolution itself." The ASA has repeatedly stressed the importance of clarifying evolution as science and distinguishing different hierarchical levels in the meaning of the term "evolution." McIntyre's piece muddies these distinctions. What meaning is intended in the title?

The implication made in the title, opening sentence, and tone of the overall article seems quite different from what is actually delivered. In fact, all aspects of evolution as science (micro-, macro-, common ancestry, that is, what good scientists consider to be the "heart of evolutionary theory") come through unscathed by McIntyre's attack. Had the article been directed more precisely and clearly at scientism, then the title of the article could be forgiven as poetic license.

There is, no doubt, a logical flaw in the three quoted statements cited by McIntyre, and they are statements made by some prominent evolutionary biologists. However, none of the particular statements come from a textbook or a peer-reviewed journal article, in which the heart of evolutionary biology are cast. I would argue that the researchers quoted by McIntyre should be *commended* for keeping their philosophical musings in the proper forum, namely their own books. I question whether it is even appropriate to so logically dissect people's individual musings. However apparent it is to McIntyre and the rest of us theists that these people have made an illogical step in their interpretation of the larger meaning of evolution, they made the step nonetheless and felt compelled to do so. I doubt if their minds would be changed by us pointing out how their casual musings contained logical flaws. In fact, I am quite sure they would see the logic itself differently.

Despite my problems with the article, I believe McIntyre provides a useful reminder of what many others have shown before: a dismissal of God's existence is not logically warranted on the basis of evolutionary theory. As an equally useful reminder for Christians, I would add that a belief in God does not logically warrant antagonism to evolution as science. Let's be more precise in our finger pointing and less carried away by catchy titles.

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Mathematical Impossibility

The book, *A Case against Accident and Self-Organization* by Dean L. Overman, has been capably reviewed by Charles E. Chaffey in the March 1999 issue of *PSCF*. Perhaps the greatest weakness of the book is to claim mathematical proofs in ways that are not consistent with the nature of mathematics itself. The author puts forth a quite reasonable argument: The probability that just chance occurrences led to the universe as it is, and in particular to life itself, is very low. But he overstates what he has shown by insisting on calling any probability less than 10^{-50} a mathematical impossibility (even probability 0 is not the same as mathematical impossibility). It appears that the author wants the authority of mathematical proof, but by insisting on this line of argument, he weakens his case, certainly for the professional mathematician.

Overman is unfortunately not quite well enough versed in mathematics for his illustrations to work for the mathematically informed. In his appeal to the Fibonacci sequence as "a mathematical code in nature left by an intelligence," he completely misses the fact that although the Fibonacci sequence has a lot of structure, it has very little "information content": it is generated by the very simple difference equation $F_n = F_{n-1} + F_{n-2}$. In fact, mathematical biologists, who have studied the formation of patterns like leopard spots and tiger stripes, have observed similar situations where the patterns are the consequence of encodings which are not as complicated as the patterns they form. In his argument that the "information content" in DNA is too high for chance, he appears to be unaware of fractals, where, like the Fibonacci numbers, simple generation schemes can provide very intricate patterns.

The author manages to fall into some of the very traps he warns his reader about at the beginning of the book. In making the statement that "the paradigm for the emergence of life contains algorithms which must have at least as much information content as the genetic messages they claim to generate" (p. 85), he makes the implicit assumption that there is some sort of "conservation of information content." This sounds plausible, but by a very similar argument it might be claimed that a person is completely determined by the gametes that first join together at conception. His argument that "DNA can function as a code only if its base sequence is not determined by physical and chemical laws" (p. 88) relies again on underlying assumptions, some of which are suspect because of the way the codes themselves physically cause the features of the living organism they encode. The author's discrediting of computer simulation misses the point because he confuses the complexity of a compiler with the simplicity of a very simple computer program (like one that generates the Fibonacci sequence).

I would agree with the author's conclusion that "Life appears to be formed only by a guided process with intelligence somehow inserting information or instructions into inert matter ... Something besides chance caused and is causing life" (p. 101). But I

would state it very differently. As stated, there is the underlying assumption that there is a separation between the very existence of "inert matter" and the "inserting" of information.

The big issue concerning this book is whether or not his arguments hold water. I would say that many of them include much reasonable cause for reflecting upon the great unlikelihood that all which we see truly came from nothing (Rom. 1:19–20), but *they are not mathematical proofs*. To the extent that he tries to present them as such, I as a mathematician must protest. To the extent that he may have overlooked other possibilities in many of his arguments, I would say they may be flawed.

The ultimately important observation is that there is plenty of evidence for Personal design in the universe in which we live, and that those who swallow modern "chance" folklore overlook this evidence to their own peril.

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On Harold Booher's *Origins, Icons and Illusions*

After reading the book review of *Origins, Icons and Illusions* (*PSCF* 51 [September 1999]: 201) by Eugene Bowser, I felt compelled to comment on what I believe are serious misinterpretations by Bowser. First, let me note that I was a critical reviewer in the production of this book, so I am familiar with the intent of the author in writing the book and with the content of most of the chapters.

In his review, Bowser makes a number of statements that clearly infer that Dr. Booher is quite unqualified to write the book. For example: "His lack of expertise in the field is revealed in his apparently unquestioning acceptance of Creation Scientists' claims ..." However, I believe Booher's qualifications should be judged by the book's content. Booher has indeed covered a broad range of material in the book, on which he had worked for fifteen years. He utilized capable reviewers in a number of fields to help eliminate errors.

In regard to misinterpretations by the reviewer of the book, I believe he fails to note that Booher has attempted to give a clear picture of the different positions on a number of important issues. To do this, Booher often quotes directly, e.g., from some who espouse views of Creation Science. This seems to be a major objection of Bowser to the book. However, it is not clear what Bowser means by "Creation Science." He uses that term five times in his review. In the cases where pages are cited, Bowser applies the term to issues of "Cosmology," that have very little to do with what biologists consider "Creation Science." In one instance (p. 31) where Booher is giving an example of "circular reasoning," Bowser considers this to be a real statement of Booher's views. Booher does have a section dealing with "creation science" in chapter 15, but Bowser makes no reference to this portion of the book in his review. Chapter 15 is particularly well written and gives a good description of various theories of origins, including creation science and intelligent design. If Bowser had read that chapter carefully, he would have found that Booher is much more favorable to intelligent design theories than to what is usually termed "Creation Science."

In addition, I would note that *Origins, Icons and Illusions* has a very extensive bibliography (85 pages of notes and references). It is written so that serious readers can evaluate the various scientific positions for themselves. I would note that Bowser does conclude his review on a more positive note, when he says: "... Booher does provide an excellent critique and an opportunity for the reader to carefully rethink his own position ..." I would agree, but I wish there were not so many negative comments regarding the book earlier in the review.

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Clarification of the Prediction Sets

Mills response in *PSCF* 51 (September 1999): 209f to my communication,[1] indicates to me that I have not written clearly. He says that I cite experimental results rather than predict. This is the scientist's approach. However, as a philosopher, I note them as examples of what should be either a trend or somewhat isolated observations. These few results have little relevance compared to the next 500 or more. The scientist's work, as he notes, must take into account current results. But the philosopher looks behind and beyond past and current procedures, observations, and theories, asking what they can mean.

To clarify "efficiency," let me suggest an analogy. There are still factory buildings where power shafts run the length of the shops. No longer used, they are

left in place when they are expensive to remove. Other shops of similar age have only the holes where pillow blocks were once attached. Either condition reveals that machines were originally driven by a single steam engine or by a water wheel, whereas modern design has electric motors at each machine. So it would be irrational to provide pillow blocks and shafts in a newly constructed factory. But the design may provide extra conduit for anticipated new technology.

The questions then are: Are there organs and genetic material in creatures that are like the shafts, no longer functional? Are some of these items functioning in a new context? Affirmative answers here strongly support a view like Van Till's. On the other hand, are there innovative functions served by new designs, especially if similar problems are solved differently in various organisms? Such would support the view that creatures possessing them came directly from the hand of God, much as single- and three-phase electric motors bear witness to Steinmetz' genius. This is the province of the multiple input views held by Mills and most promoters of intelligent design theories.

I readily grant that Mills formulates his theories to match all the available evidence. But is his espousal of many divine interventions a rear guard action? In 1968 he wrote that rats and mice were independently created because their respective cytochrome c's did not match.[2] The discovery of additional cytochrome c's pushed him to allow for a common ancestor for both genera in 1992.[3] Will future evidence suggest a common ancestor for the Muridae and other rodent families as it now seems to do for the murine genera *Mus* and *Rattus*?[4]

My original study anticipated two primary possibilities. First, if species, genera, or families came directly from God's hand, then novel structures, genes, proteins, and controls will be encountered more and more often. In addition, an essential function will be found for "junk DNA": Intelligent design does not introduce useless oddments. This fits what was termed multiple input theories. In contrast, if creatures come to be by natural descent according to the divine plan and purpose (functional integrity), such novelty will not be discovered. Emerging structures and operations will be governed by controls modified from earlier ones,[5] with at least some retaining their original functions. Genomes will contain unexpressed genes and other accumulated debris.

Will future discoveries support one or the other extreme, or an intermediate position? The answer requires either patience or the gift of prophecy. As a mere philosopher, though I may look for trends in the work of scientists, I have to wait.

Notes

[1]David F. Siemens, Jr., "Two Prediction Sets and Their Consequences for Applying Intelligent Design Theories," *PSCF* 51 (June 1999): 108–12.

[2]Gordon C. Mills, "The Evolutionary Significance of the Species Variation in Cytochrome c Structure," *JASA* [*PSCF*] 20 (June 1968): 52–4.

[3]Ibid., "Structure of Cytochrome c and c-like Modifications and Origin of Genes," *PSCF* 46 (December 1992): 236–45.

[4]The genome map and accompanying articles in *Science* 286, no. 5439 (15 October 1999) are presented from an evolutionary viewpoint. How well can the data be presented within a progressive creation/intelligent design framework?

[5]Note, for example, the argument that all organisms produce DNA bases by processing RNA in S. J. Freeland, R. D. Knight and L. F. Landweber, "Do Proteins Predate DNA?" ibid., 286 (22 October 1999): 690–2.

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Corrections

I note that my article (*PSCF* 51, no. 2 [June 1999]: 114–20) suffered from some editorial misunderstandings. The most serious two of these follows. The correction in the draft copy that Bob Jones Sr. recognized the "fallen nature" rather than "sinful nature" of humans (p. 115) was left out. But as Jones claimed a "baby had no sin" (original sin), he preferred to speak of humans' spiritually "dead" or "fallen nature"—but not their *sinful* nature. While his recognition of a human having *a fallen nature* accords with orthodoxy, his Charles Finney's New School type of usage of this to deny that from conception a human is tainted with original sin and so has *a sinful nature* and original guilt was unorthodox (Ps. 51:5; Rom. 5:12–14; 7:14–23).

In footnote 4 (p. 119), my manuscript refers to the Book of Common Prayer, reading: "The *BCP* (1662) refers to 'fornication, and all other deadly sin' *(Litany)*, but repentant fornicators and adulterers are forgiven (1 Cor. 6:9–11)." An editorial error was made when the word "repentant" was changed to "unrepentant."

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Genesis Revisited or Revised?

In their recent paper (*PSCF* 51 [December 1999]: 231–43), Held and Rüst rightly insist that the biblical concept of creation need not exclude natural developmental processes and some of their suggestions for harmonizing the biblical text with developmental processes are felicitous. They wrongly assume, however, that the biblical concept of inspiration must exclude references to the primitive cultural concepts of the natural world held by the inspired writer. This false assumption leads them to make some suggestions that are more in the nature of revising Genesis than merely revisiting it.

With regard to the biblical doctrine of inspiration, Jesus made it clear in Matt. 19:8/Mk. 10:5 that inspired Scripture can and does include accommodation to primitive cultural concepts—and that in the area of faith and morals! Nor is the Old Testament's (OT) allowance of divorce for reasons other than adultery (Deut. 24:1-4) the only inspired OT law which supports the primitive morality of the Israelites rather than the higher standards of Christ. The inequality of both slaves and women to free men, for example, are built into the inspired OT law.

Since the purpose of Scripture is to give divine revelation in the area of faith and morals (1 Tim. 3:16)—yet, even in this area, accommodation to the primitive cultural morality of the times is sometimes allowed into inspired Scripture—it is evident that accommodation in the area of natural knowledge, which is outside the purpose of Scripture, is entirely possible. Also, Scripture strongly suggests that God has delegated the discovery of natural truth to humankind (Gen. 1:26–28). It would only be consistent then if his divine revelation of spiritual truth did not include revelation of natural truth but was given in terms of the scientific understanding of the times.

Held and Rüst are to be commended for wanting to be true to Scripture, but Scripture does not support their idea that "conflicts [of the scientific statements in Scripture] with scientific evidence must send theologians and scientists back to their studies, until a consensus is reached." It is entirely possible within a biblical definition of biblical inspiration for the science in the Bible to be simply the science of the times—a science now outmoded and incapable of being harmonized with modern science. Further, there is evidence that the science in Scripture is the science of the times and I have yet to see a case to the contrary.

Faced with ancient scientific ideas, it is not surprising that Held and Rüst cannot get past the second verse of the Bible in their attempt to bring it into conformity with modern science. Although they say Gen. 1:2 "strikingly resembles the scientific picture of the early earth" and later in their exposition of Gen. 1:9 marvel that the sequence of dry land arising from water is in accord with modern science, they miss two if not three glaring contrasts between Gen. 1:2/Gen. 1:9 and the findings of modern science.

In the biblical account the earth is *first* covered with water (Gen. 1:2) and only *later* does dry land appear (Gen. 1:9). In the modern scientific account the dry land appears first (as crust too hot to have an ocean cover it) and is covered with water only later, millions of years later. The sequence of events in the two accounts is exactly opposite. Secondly, in the biblical account, as Held and Rüst properly say, "the entire earth was covered by water." But in the scientific account the *entire* earth is *never* covered by water. Finally, if one interprets Gen. 1:9 within its biblical and ancient Near Eastern context, it is speaking of the earth (as a flat unmoving disc) having the sea for its foundation (Ps. 24:4; 136:6); but in the modern scientific account the sea has the earth (as a spherical planet) for its foundation. The two accounts are clearly opposed to each other.

In an earlier paper showing that concordists regularly take the Bible out of context (*PSCF* 49 [June 1997]: 85–95), I covered a number of the arguments which Held and Rüst employ. Therefore, I address here only a few additional points, especially with reference to places where I think their comments are particularly misleading.

In an attempt to avoid the solidity of the *raqia'* (firmament), Held and Rüst not only slide over the fact that both the word *raqia'* (cf. Ezek. 1:22, 23) and all of its cognate words refer to objects which have solidity, they say of Gen. 1:20: "Flying animals are said to move 'on' the *raqia'*, certainly not a solid dome." Realizing, however, that the preposition used in Gen. 1:20 can mean "in front of" or "before," they attempt in their endnote 35 to avoid this meaning by saying the preposition is the same preposition as is used with regard to the land; and since "in front of" or "before" would make no sense with regard to the land, this translation should not be used with reference to the firmament. So they opt for translating Gen. 1:20 "the flying creatures fly 'on' the air."

There are a number of problems with this "solution." In the first place, their argument can be reversed. That is, since it makes no good sense to say the "flying creatures fly 'on' the land," this translation should not be used with reference to the firmament. Secondly, they avoid the fact that it is not just the simple preposition "on" which is used with ref-

erence to the firmament, but the prepositional phrase, "on or upon the face or surface." So, if "on" is the proper translation and the *raqia'* is "air," then Gen. 1:20 should be translated: "the flying creatures fly *on the surface* of the air."

This same prepositional phrase is used in Gen. 1:2, "darkness *upon the surface* of the Deep" and in Gen. 1:29, regarding plants "*on the surface* of all the earth." But, whereas a reference to a "surface" makes perfect sense with regard to an ocean or to the earth, it makes little or no sense with reference to the air (what surface?)—yet very good sense with reference to a solid firmament. Given the historical context wherein the sky was understood to be a solid dome, it is quite understandable that the writer would refer to birds as flying "in front of" the firmament, and even from a purely phenomenological point of view, birds fly with the sky as a background, that is they fly "in front of" it, as the text says. This makes much better sense than "flying on the surface of the air," a phrase even moderns would not use, much less ancient peoples.

With regard to Day 5 (p. 230), Held and Rüst are aware that the creation of birds at the same time as fish (Gen. 1:20) and before reptiles (Gen. 1:24) is contrary to the order of events as indicated in the fossil record. They, therefore, quite rightly state that the Hebrew word used in Gen. 1:20 is not "bird" per se, but "flying creature." But then they quite wrongly imply that the reference is to flying insects, excluding birds. This is quite clearly forcing the text of Genesis to speak against its will.

In the first place, if "flying creatures" in Gen. 1:20–22 is not a reference to birds, then the account has no reference to the creation of birds, and that seems quite unlikely given the skeleton nature of the account and the fact that birds are one of the most highly visible and interesting parts of the creation, certainly not a part of the creation that would be ignored in favor of mentioning flying insects. Along this line, it should be noted that all proto-scientific peoples, such as the Hebrews were, organize the zoological world around them into three to five basic categories. The OT employs four of those five basic categories: Fish, Bird, Snake, and Mammal (Gen. 1:26; 1 Kings 4:23; Ezek. 38:20), missing only Wug (worm + bug).[1] Flying insects may well have been included in the "flying creature" or Bird category (bats were included, Lev. 11:19), but birds are the primary and dominant creatures in the category. It is incredible that this basic Bird category does not include birds. I would only add that Gen. 1:21 refers to "*every* flying creature" and since birds are flying creatures they are necessarily included.

Finally, at the end of their paper and in note 17, Held and Rüst reject the idea that the earth in the OT is flat, saying that I have read this idea into Scripture from purely external ethnological data[2] and that William Tanner was also mistaken in saying that the earth in the OT is not a spherical planet.[3] In opposition to my and Tanner's conclusion that "earth" in the OT is flat, they refer to J. B. Russell's book, *Inventing the Flat Earth: Columbus and Modern Historians*, as having demonstrated "the recent origin of the 'three-story-universe' myth." A close reading of my paper will reveal that I rely on historical and biblical data and not just ethnological data; but, the more important objection here is that Russell's book is completely irrelevant to the issue of the OT understanding of the word "earth."

Russell showed that most Western educated people, including most Christian leaders, *after* the fifth century B.C. believed that the earth was spherical. Russell did not attempt in any way to show that people prior to that time and especially people in the ancient Near East in OT times did not believe in a three-story universe with a flat earth. Russell's book gives no data of any kind that would falsify the conclusion that the Hebrews thought of the earth as flat.

The basic problem with all day-age concordism is the same as the basic problem with creation science: it rests ultimately upon the unbiblical assumption that the divine inspiration of Scripture excludes any accommodation to primitive cultural ideas of the times, and it has no positive coherent objective evidence to offer in place of the overwhelming evidence supporting consensual conclusions. Both concordism and creation science offer little but superficial reinterpretations of the biblical and/or scientific data, reinterpretations which implicitly replace the data with illusions—albeit if one prefers illusions day-age concordism is preferable to creation science because it does not cause the Church to repeat the mistake made with Galileo; and that is the primary saving grace of Held and Rüst's paper.

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[1]For further discussion, see my "The Meaning of Min, 'Kind'" in *Science & Christian Belief* 9:1 (1997): 47–56.

[2]Paul Seely, "The geographical meaning of 'earth' and 'seas' in Gen. 1:10," *Westminster Theological Journal* 59 (1997): 231–55.

[3]W. F. Tanner, "'Planet Earth?' or 'Land'?" *PSCF* 49 (1997): 111–15.

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American Scientific Affiliation

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