PERSPECTIVES on Science and Christian Faith

JOURNAL OF THE AMERICAN SCIENTIFIC AFFILIATION

The Fiftieth-Volume Anniversary Issue

The *Journal of the American Scientific Affiliation* At 50:
Modest Beginnings, Maturing Vision, Continuing Challenges

Is "Progressive Creation" Still a Helpful Concept?
Reflections on Creation, Evolution, and Bernard Ramm's
Christian View of Science and Scripture—A Generation Later

Do Phyletic Lineages Evolve from the Bottom Up
or Develop from the Top Down?

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

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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.

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4. All manuscripts should be typed double-space on good quality 8½ x 11 paper (computer copies should be printed letter-quality).
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Editorial

A Golden Moment

The half-century of our *Journal* has seen such enormous advances in understanding the natural world that few are now able to grasp even the broadest sense of the current picture. New disciplines and technologies have emerged at a breath-taking frequency. A burgeoning scientific force and new, rapid, automated methods for obtaining data demand more and fatter journals. We now are specialists within our speciality.

The same blossoming of knowledge and number of participants has taken place in the field of science and religion—a discipline that hardly existed fifty years ago. There is a long tradition of essayists and book writers on science and religion themes but the recent upsurge of journals, books, organizations, and conferences would have been unimaginable to the few who founded this *Journal.*

Their vision wisely included the social sciences (psychology, psychiatry, sociology, and anthropology) as grist for the *JASA* mill along with the traditional physical sciences and the contributions of philosophers and biblical scholars. New fields and their attendant questions have quickly drawn the attention of our writers while the old chestnut "evolution" continues to provoke much discussion. The sidebar comments of British biologist Thomas Huxley and ASA Founder F. Alton Everest draw attention to our task and the way that we should carry it out. The minefield of public policy is one that should cause us to practice particular restraint in proclaiming *the* Christian response—whether on global warming, cloning, nuclear power, dietary practices, or the next issue on the horizon.

As we contemplate the next half-century, it seems that ethical questions will be of increasing importance both in the possibilities offered through the advance of science and in the way that science is carried out. *PSCF* will continue to be of value only through the perceptive analysis of issues and articulate presentation to a diverse audience.

Our anniversary issue offers something old and something new. We welcome your response.

J. W. Haas, Jr.
haasj@mediaone.net

"Science ... warns me to be careful how I adopt a view which jumps with my preconceptions, and to require stronger evidence for such belief than for one to which I was previously hostile. My business is to teach my aspirations to conform themselves to fact, not to try to make facts harmonize with my aspirations."

— Thomas Huxley, 1860

"We consider our job well done if we can present a Bible-teacher, a pastor, or a university student an adequate survey of the various views held on a given problem and the historical and scientific data pertaining to it. The problem of the church is principally one of plain ignorance of the many and complicated factors entering into a wise interpretation of the Scriptural accounts."

— F. Alton Everest, 1951

Young Scientists' Corner

Called to Stewardship

by H. Scott Althouse,* senior, Eastern College, St. Davids, PA 19087

Environmental stewardship is an overarching, contextual call for all Christians. Just as love and our concern for justice shape our daily lives, so too must stewardship of the environment be a permanent reality in how we determine to live within the established limits of creation and the rest of humanity.

My Christian journey has been shaped by the constant intervention of God in my life and his glorious revelation through creation. This journey has reaffirmed my purpose in life—to be of maximum service to God and my fellow human beings. Like every Christian, I am called to love God with everything and to love my neighbors as myself. I have come to see myself as a responsible steward of creation. I base my motivation to enter the environmental field from the awesome nature of God's character. Our Father is one who is concerned with the intricate details of our personal lives. The Lord is the Lord of justice, righteousness, and shalom. Our faith and our commitment to caring for creation has to reflect our love for the Creator by bearing his image in all areas of our lives.

Throughout my life I have had a great love for the outdoors. Growing up as a young child in Lancaster County, PA—the pristine garden spot of America—I developed an early yearning for the land. Weekend fishing trips, camping outings with my family, and week-long outdoor expeditions with the Boy Scouts left powerful impressions on my shaping worldview. The importance of creation and its healing and spiritual qualities cannot be overstated. God's incredible revelation through creation remains the most powerful and cleansing component of my life.

My childhood yearning for the creation led me to the majesty of the Colorado Rockies following high school. I spent many sunsets on Rocky Mountain peaks watching the alpenglow gradually fade away. The pristine beauty of these virtually untouched natural areas provided a spiritual refuge for me. In the wildness of Colorado, I was able to consider the reality of my fallen nature. It was here that I experienced hope like never before. God began to talk to me and increase my awareness of the Great Reality. I am so grateful for his glorious provisions and also the decisions and hard work by many people who helped to preserve this corner of God's creation. Had there not been a place to escape in my time of struggle as a young adult, I may not have experienced the direct revelation and Truth of God in my life. It simply may have been too late. But in the wildness of the Rockies I could not deny the Creator; he began to call me back to a life of integrity and love.

Thankfully, the intervention of Christ awakened me to the Truth and motivated me to change my lifestyle and expand my worldview. After this critical turning point, I recommitted myself as a diligent follower of Jesus Christ. Looking back, I am not sure that I really knew what that meant at the time, but I did know that the modern secular worldview resulted in emptiness and misery for me. I was now totally open and willing to receive God's grace and powerful changing forces in my life. For this reason, I have chosen a life of service that is aimed at protecting God's glorious creation.

ASA Student Member

I have continued my education and God constantly deepens my vocational vision. As a double major in political science and environmental studies, I have sought to expand my personal vision of what, specifically, Christians can offer the environmental movement. Is it possible to overcome the widely held opinion that Christians are largely responsible for the ecological crisis? What can Christians learn from the secular environmental community? These are some of the questions I have identified to be of paramount concern in order for Christians to more aptly lead the environmental movement and to become better stewards of creation, writ large. Moreover, through my education at Eastern College, Au Sable Institute, and the American Studies Program—and my constant prayer and meditation with a community of believers—I have come to understand my vocation of creation care.

This brings me to the key issue of responsible Christian stewardship of the environment. Primarily, we are managers of the land, servers of God's created order. I acknowledge that God maintains ownership of the earth and that humanity's dominion is a derived authority. We must observe God's perfectly whole handiwork where humanity has not corrupted it. Developing care, appreciation, and love toward creation is completely necessary. Upon observing degradation to the creation, Christians must embrace an environmental mandate: the biblical command to care for God's creation. That is, imitate Christ as reconcilers and continue restoration. We shall develop a new awareness and renewed sense of servanthood toward all creation by mimicking Christ.

We are managers of the land, servers of God's created order ... Developing care, appreciation, and love toward creation is completely necessary.

What I have termed the environmental mandate is outlined in Scripture. We must blow the whistle on corrupt and poor stewards: "Men, why are you doing this? We too are only men, human like you. We ... are telling you to turn ... to the living God, who made heaven and earth ... He has shown kindness by giving you rain from heaven and crops in their seasons" (Acts 14:15–17). Once we are aware of our position regarding Christian stewardship, we must claim responsibility and show others the Truth. "For since the creation of the world, God's invisible qualities—his eternal power and divine nature—have been clearly seen, being understood from what has been made, so that men are without excuse" (Romans 1:20). Moreover, responsible Christian stewards will use their faith in Christ to allow God to work through them in order to imitate God's dominion for the reconciliation and redemption of the created order.

The responsible stewardship of creation is a primary duty for all of humanity, especially Christians. I have recently increased my sense of Christian duty regarding the numerous environmental issues confronting the Earth and the human race: global warming, species extinction, human population growth, resource consumption, air and water pollution, sustainable development, and energy use, to name a few. But what, if anything, can responsible Christian stewards learn from the secular environmental community?

Today many environmental groups now realize that ecological issues are moral issues that only religious epistemology can truly answer.

Over the past two years, I have worked in Washington, DC with a number of secular environmental groups on public policy, legislation, and grassroots organizing. I dealt with a wide array of individuals with varied perspectives and motivation for working in the environmental field. No matter if the issue at hand was clean water, endangered species, takings legislation, or national forests, the message God was sending to me was the same. At the Sierra Club, the Clean Water Network, and Earthjustice Legal Defense Fund, the common denominator was that these groups are desperately trying to reach out to religious people. This "secular" environmental community has acknowledged that pure science and reason alone are unable to convince the American public about the severity of the ecological crises. Scientific reasoning has not sufficiently motivated people to deal with these environmental issues. Today many environmental groups now realize that ecological issues are moral issues that only religious epistemology can truly answer. There is a strong

desire in Washington, DC to broaden alliances and build moral coalitions in our attempt to address these broad concerns and restore creation.

I emphatically believe that the biblical mandate of creation care is the answer and the best philosophical foundation to lead the secular environmental community and the rest of humanity in mitigating the ecological crises through the millennium. So in response to the widely-held paradigm that the Judeo-Christian worldview is largely responsible for our current ecological crises, I say, "Perhaps, but we Christians shall also lead humanity out of these crises through the Spirit of reconciliation and our commitment to creation care." Spiritual problems require spiritual solutions. Christians must continue the concerted revival of our culture and our reconciled concept of stewardship so that all people may receive the fruits of righteousness through faith in Jesus Christ. "And what does the Lord require of you? To act justly and to love mercy and to walk humbly with your God" (Micah 6:8). Moreover, a holistic Christian response to the environmental movement must be one of action and leadership.

Christians must continue the concerted revival of our culture and our reconciled concept of stewardship so that all people may receive the fruits of righteousness through faith in Jesus Christ.

This revival will be led by Christians who see themselves as responsible agents of God's righteousness and justice. Responsible scholarship leads us to Christian advocacy of the creation and social action. Christians are to influence public policy, particularly legislation that affects our ability to be responsible stewards of creation. We must confront the secular fallacies of the deep ecology movement with faith and obedience to God's calling each of us to be responsible stewards of his creation. The lifestyle choices we make must ultimately and sustainably bring all of our lives and culture under the lordship of Jesus Christ. Since everything is covenantally bound to the Creator, the earth will reflect his glory as the children of God continue to restore creation.

We ought to reinforce and encourage our mutual commitments to utilize all of our talents for the proper stewardship of God's creation and to the benefit of God's Kingdom. I am grateful for the American Scientific Affiliation for articulating the legitimacy and necessity for Christians to engage the natural sciences. So too are the disciplines of theology, ethics, politics, law, economics, and business the responsibility of Christian stewards. Thankfully, there does exist a concerted Christian effort to engage the modern environmental movement. To these pioneers and trailblazers, my generation owes a debt of gratitude. Thank you. ✯

News & Views

Science & Faith in Norway

*by Inge Frette**
Oslo, Norway

I have followed the discussion about the relationship between science and Christianity in the U.S.A. through *PSCF*, ASA's newsletter, and the ASA e-mail discussion group. I have found this interesting since it shows strong geographical differences. Issues that are very important among evangelicals in the U.S.A. may hardly be addressed in Norway. The situation in Norway is very peaceful compared with the situation in the USA.

The church situation in Norway is different from what you have in the USA. We have a confessional Lutheran state church—Church of Norway (CN)—where 85% of the Norwegian population are members. Thus we have an official religion—Lutheranism. But we also have many free churches of other denominations. I would guess that 10% of all Norwegians would define themselves as evangelicals, split 50–50 between CN and the free churches.

Almost all Norwegian children go to public schools. There are few private schools, and almost no one is home schooled. Since we have an official religion, all children in the schools take obligatory classes in Christianity every year. The relationship between creation and evolution is not presented as a conflict. I cannot see how a public school committed to both Christianity and science can do that. My point here is simply to stress that we have not had any heated debates caused by law suits regarding the teaching of evolution in the schools.

When it comes to the view of the relationship between the Bible and science, evangelical theologians in Norway differ from many of their friends in the USA. For example, among evangelical biblical scholars in CN, the full inerrancy of the Bible has never been defended. The infallibility of the Bible is limited to doctrinal and ethical matters. The historical critical methods are also extensively used. No evangelical student preparing for the ministry in CN learns to take the first chapters of Genesis to be very literal. The Fall will still be defended, I think. When it comes to apologetics, there has been no tradition in CN for the evidentialism that has been so widespread in the USA in this century. That the truth of Christianity depends on there being no conflict between all the verses in the Bible and science is quite foreign in CN. Things may be different at the seminaries of the free churches. But these seminaries are very small, and I am not sure whether serious research is going on among the teachers there.

There are still many Christians that are skeptical about the theory of evolution, not because they think the theory conflicts with the Bible, but mainly because they think there is not enough evidence for it. I do not know any people that are young earth Christians, but I have been told that there are some in the free churches and even among people in Christian organizations affiliated with CN. These people are probably laypeople with no training in science or theology. I really doubt one will find any young earth Christians in Norway with a graduate degree in the natural sciences or theology. As a student at the University of Oslo some years back, I got to know many Christian biology students involved in InterVarsity student work. Each was a strongly committed theistic evolutionist.

Some weeks ago, the major Norwegian Christian newspaper published a two-page article written by another Norwegian ASA member. The article criticized the young-earth Christian position. No response from a young earth Christian has occurred yet, which confirms my suspicion that there are not any academics among them.

I know of only one organization in Norway which deals with the relationship between science and theology. This organization focuses on questions in ethics and philosophy of science, but its main focus is to attack the theory of evolution and to defend creationism. The members, however, are old earth Christians.

Although there are many Christian professors in the natural sciences at the universities, they show very little interest in working constructively with the relationship between their science and theology. John Polkinghorne, in contrast, has done so quite well. I do not know why, but maybe the borders between the different disciplines are too difficult to cross here in Norway. ✯

*ASA Member

The *Journal of the American Scientific Affiliation* At 50:

Modest Beginnings, Maturing Vision, Continuing Challenges

John W. Haas, Jr.*
with David O. Moberg, Richard Bube,* and Wilbur Bullock***

The Journal of the American Scientific Affiliation (Perspectives on Science and Christian Faith *beginning March 1987) has offered discussion on science and (primarily) Christianity for fifty of the fifty-eight years of ASA history. Seven editors have served for periods of two to fifteen years. Content has been wide-ranging, occasionally controversial, and, in retrospect, often far ahead of the Christian community in addressing new issues. Our purpose remains that of open dialogue on questions of science and faith within the framework of evangelical Christianity.*

Golden anniversaries are rare species in the field of science and religion. Only the British *Journal of the Transactions of The Victoria Institute* has had a longer history.[1] As *Perspectives on Science and Christian Faith* (*PSCF*) reaches 50, let us consider our journal through the eyes of some of those who have been responsible for its production. The 199 issues reflect the thought of two generations of evangelical, physical and social scientists, and scholars from related disciplines, such as theology, philosophy, and history. ASA's pioneers soon learned that their "enthusiasm and dedication [was] fully matched by their inexperience."[2] What had been viewed as simply weaving the Bible and science into a common cloth became more complex. Fifty years later the task has become far more elusive, as scholarship has opened up the complexity of the task. Controversy and diverse views have enlivened our pages as we have debated classic questions and new questions that have emerged from the culture of ongoing science. Our study will reflect a perusal of the 8,600 pages of copy and the reflections of some who have brought them to you. *PSCF*, the most public face of the ASA, represents the ongoing attempt of Protestant evangelicals to grapple with the scientific issues that influence their faith and worldview.[3]

*ASA Fellow **ASA Emeritus Member

The first constitution of the American Scientific Affiliation (1942) established two goals for the fledgling organization: (1) to promote and encourage the study of the relationship between the facts of science and Holy Scriptures and (2) to promote the dissemination of the results of such studies. It was not until 1949 that a periodical took shape.

Fig. 1. Cover of the first issue.

The *Journal of the American Scientific Affiliation* (the *Journal*) appeared January 7, 1949 (Fig. 1). For the first year, it was subtitled, *The American Scientific Affiliation Bulletin*. Editor Marion D. Barnes indicated that each submitted paper would be reviewed by specialists in the field before publication, while those presented at the Annual Meeting would be evaluated by the discussion that followed the presentation. In the early years, most papers came via the latter route. Today, the opposite is the case, partly because of the time pressures in annual meetings which result in very short blocks of time for individual presentations. The cover design for the initial nineteen-page mimeographed issue remained

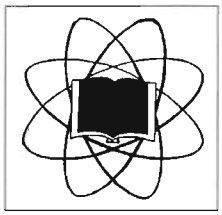

Fig. 2. The new Bible graphic first appeared on the March 1952 cover.

constant until 1964, except for some adjustment of the Bible graphic to include the Bohr model of the atom in March 1952 (Fig. 2). In the initial editorial, ASA President F. Alton Everest extolled the membership to send a copy of the *Bulletin* to each institution of higher learning in the United States. For Everest:

> The work of the ASA is just what we few members, by the grace of the Lord, make of it. If we are lethargic, the work will shrivel; if there is no vision, no progress.[4]

The founders of the *Journal* chose the large page size favored by most science journals of the time rather than the smaller size of the literary quarterlies to emphasize the scientific roots of the publication. They (wistfully) hoped that it would be accounted a place along with the *Journal of the American Chemical Society* and *Nature* in science libraries.

Over the years the number of pages per issue has gradually grown from nineteen to eighty. In 1964, Editor David Moberg initiated the blue cover which reigned until 1969, when Editor Richard Bube introduced the current four-color rotation. Bube also added graphics designed to make the journal more appealing.

The early years saw contributions by major evangelical leaders such as Bernard Ramm, Carl F. H. Henry, Alan MacRae, Laird Harris, and Wilbur Smith. This close cooperation with evangelical theologians would not be maintained as scientists felt compelled to take positions unacceptable to their theological allies. In the early days, the ASA had a higher representation of working scientists and engineers. Buzzwords such as paradigm, deconstruction, social construction of science, deep ecology, and methodological naturalism had not arisen to require the aid of philosophers, sociologists, and historians of science to interpret the word maze.[5] We are constantly challenged with the need to publish that which is scholarly and accurate yet accessible to our intended audience.

And now a word from our editors ...

David O. Moberg, Editor (1962–1964)

At least two significant changes occurred during my editorship. Most obvious was a new logo and color for the cover. The March 1964 issue (vol. 16, no. 1) saw the introduction of a blue cover with the double-arrow logo created by Robert Friderichsen under the supervision of our editorial staff (Fig. 3). The logo has been used in ASA ever since.

> The symbol can be interpreted in many ways, but we see it primarily as a representation of the fact that two perspectives, two types of truth, two sources of knowledge, two commitments, confront each other and converge in the ASA. We aim to remain on the exciting frontier of the confrontation of Christianity and science.[6]

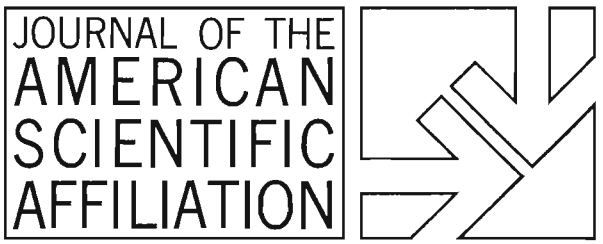

Fig. 3. The new ASA logo appeared on the top of the March 1964 cover.

The second major change was the introduction of abstracts for all major articles. This practice facilitates scanning by our readers and, more importantly, allows the inclusion of ASA contributions in abstracting and indexing services.

A "Letters to the Editor" section was introduced in December 1962. In March 1963, we added a "News and Notes" section to replace the columns in specific disciplines (Archaeology, Biology, Chemistry, Philosophy, Sociology, etc.). Former columnists became contributing editors and this new section, which had a greater variety and scope, incorporated the content of the previous columns. Some notes were also used as fillers at the ends of articles.

A new name for the *Journal* was considered. Don Fair won a name contest with the title, *Science and Christian Faith,* but the Editorial Board recommended *Theos and Cosmos.* ASA's Executive Council resolved the issue by its decision to retain the current name.[7] Numerous suggestions for future ASA ministries appeared. Some have been implemented, but most are as fresh and valid today as they were over three decades ago.[8]

There was no oversupply of publishable manuscripts. So, for example, papers on "Ethical Decisions of Christians in Science," given at the April 1962 program of ASA's North Central Section were published in September, and several from the 1962 annual meeting were in print by December.

In terms of content, one subject exceeded all others: evolution. Only two of the eight issues did not

have a paragraph or more on the subject, and the September 1963 issue (vol. 15, no. 3) was almost entirely devoted to it. Its introductory editorial commented on the emotional overtones and variety of meanings attached to words like "evolution," "creationist," and "theistic evolution;" the oppositional spirit that infuses far too many discussions on the subject; the infusion of both religious traditions and the spirit of the age into such exchanges; the confusion of *evolution-as-research* with *evolution-as-worldview*; the uncommon combination of Christian commitment and scientific knowledge in ASA's membership; the importance of keeping open lines of communication among members; the need to be open to new scientific data but cautious of value judgments (especially interpretations based upon scientism); and the need to retain ASA's positive stand on the doctrine of God as Creator and to "help our contemporaries see the relevance of the Bible and of Jesus Christ for their lives."[9]

At least two significant changes occurred during my editorship. Most obvious was a new logo and color for the cover ... [and] the introduction of abstracts for all major articles.

Additional articles, letters, and news notes touched directly upon evolution and still others on the closely related subjects of creation and *The Genesis Flood* by Henry M. Morris, an ASA Fellow, and John C. Whitcomb, Jr., on which there were several book reviews and responses.[10] A news note in December 1963 reported the formation of a new organization, the Creation Research Society (CRS), with several ASA members on its steering committee. CRS's belief statement emphasized, *inter alia*, that "the account of origins in Genesis is a factual presentation of simple historical truths" and that "... the Noachian Flood, was an historic event worldwide in its extent and effect."[11]

Not directly stated but in the background of the founding of CRS were earlier attempts to persuade the ASA to adopt the positions that God created the world and its inhabitants in six 24-hour days and that the great flood of Genesis 6–8 covered the entire planet. If the ASA had committed itself to those and related interpretations of the Scriptures, the religious and scientific diversity of its evangelical membership would have been diminished by the departure of theistic evolutionists, Christians who interpret the flood as a regional event, and others compelled by biblical hermeneutics or scientific knowledge to interpret much of Genesis 1–11 as nonscientific and prehistoric literary accounts, rather than as positivistic science records. As I wrote in response to a letter by William J. Tinkle, one of CRS's founders:

> The ASA has no official position on evolution ... Can there indeed be any *one* Christian interpretation of Genesis and related passages as long as Christians remain human, hence finite beings who know only in part, seeing things as if "in a glass darkly"?[12]

I added some questions. One, to my knowledge, has not yet been answered by research: "Has anyone made a careful scientific study of the influences of *theistic* evolution on Christian faith as distinct from faith in human interpretations of the Bible?"[13]

Reactions of readers ranged widely. Several believed that God *could* have created living things through an evolutionary process, but he as Truth *could not* at the same time declare that he did so through a series of fiat acts.[14] Regarding ASA's lack of an official position:

> This seems to say that the ASA does not stand for anything. If ... [that is so], we will never make much impression either on the scientific or the religious world.[15]

Another reaction was disgust with "the constant harping on evolution and Christian dogma ... [After] two hundred years to talk about this ... , nothing has changed of any consequence in the thinking of extreme conservatives, middle-of-the-roaders, or liberal Christians. Furthermore, we haven't even dented the scientific community ..."[16]

The 1962–1964 volumes (vol. 14–16) are still treasure troves of rich materials on Christian values in relationship to the assumptions, commitments, ethics, findings, limits, methods, and theories of the sciences and many other aspects of science and Christian faith. Amazingly little has been outdated by technical and scientific developments. Most materials have confirmed and strengthened our faith in Jesus Christ as the Living Word and the Bible as God's Written Word (not merely "containing" it).

Russell L. Mixter, Editor (1965–1968)

Russ, at 92, found himself unable to comment on his editorial experiences. The best record of his life and ASA contributions is the paper, "Christian, Teacher, Scientist, Mentor: Dr. Russell L. Mixter," presented by Dorothy F. Chappell at the Fiftieth Anniversary meeting of the ASA in 1991.[17] We are much indebted for the contributions of this humble

biologist who worked under the pressures of a crushing work load and an environment often hostile to the purposes of the ASA.

Richard H. Bube, Editor (1969–1983)

I joined the American Scientific Affiliation in the early 1950s. I had just received my Ph.D. in physics from Princeton University in 1950. The ASA had been formed in 1941 by a small group primarily to be of service to college and university students as they encountered questions interrelating science and their Christian faith. The ASA has had uncertainties through the years trying to define its identity. Should it be fundamentally: A service organization to help pastors, laypeople, and students? An evangelistic branch of the church to convert scientists to Christianity? An academic association to promote scholarship in dealing with scientific philosophy and Christian theology? Or a part of a futuristic vision which sought to identify science and Christianity more closely in one discipline? This uncertainty is understandable. For the years of my association with the ASA, I have repeatedly testified that it is one of the few such groups in the world (others are Christians in Science and The Victoria Institute both in England) which seeks to maintain both the integrity of authentic science and the integrity of authentic Christian theology.

Editorial Experiences

After the completion of my year as ASA President (1968), I became Editor for the *Journal of the American Scientific Affiliation* (the *Journal*), a position I held for the next fifteen years until 1984. It was a remarkable opportunity that really allowed me to enjoy my editorial predispositions. During the years of my tenure as editor, I held every job simultaneously. For fifteen years, with the able and constant help of Book Review Editors, Stephen W. Calhoon Jr. and Bernard J. Piersma, and Consulting Editors whose number increased from eighteen to twenty-five, I had the fun of serving as editor-in-chief, managing editor, correspondent to referees, advertising manager, photographer and illustrator, proof reader, and layout and paste-up of the "dummy" designer. I was also responsible for whatever else might need to be done. It was great! And it was all done by typewriter and by hand—no computers were involved during this ancient period.

The Consulting Editors who served faithfully for the same total fifteen years included Dewey K. Carpenter, Gary R. Collins, Walter R. Hearn, Robert D. Knudsen, Gordon R. Lewthwaite, Russell Maatman, Russell L. Mixter, W. Jim Neidhardt, E. Mansell Pattison, and Claude E. Stipe. I was also constantly supported by the others who served for part of that period and by the Executive Office with Executive Directors, H. Harold Hartzler, Bill Sisterson, and Bob Herrmann. The number of published pages per year of the *Journal* increased from 136 in 1969 to 256 in 1983.

The *Journal* naturally shared in the same search for identity as the ASA itself, as mentioned above. It was my conviction that the *Journal* must, of course, be academically sound both in science and in theology, but that it also ought to be enjoyable to read and challenging to its audience. I therefore used a variety of techniques that had not been used before and included cartoons and photographs in the text and on the cover. Even so, the contrast between the *Journal* and almost any other Christian publication deepened over the years. Most other publications adopted styles and devices for catching the eye of the Christian public, while we had as our primary goal to keep the *Journal* a semiprofessional publication with strong scientific and theological integrity.

Special Points of Interest

In this section, I list a few of the hopefully interesting variations and innovations in the *Journal* between 1969 and 1984.

June 1969. A new feature, "What Do You Think of That?" was introduced, listing quotations from contemporary publications of a provocative nature related to the consideration of science and Christianity.

June 1969–September 1969. The authors of the articles in these first three issues read like a Who's Who of ASA: W. Jim Neidhardt, Donald Munro, V. Elving Anderson, Irvin W. Knobloch, Russell Heddendorf, Wilbur Bullock, Walter Hearn, Jerry Albert, etc.

September 1969. We recruited the artistic services of Annie Bien, at the time a high school classmate of my daughter. She drew headings for sections and also contributed cartoons and other drawings on occasion through 1973. Her first artwork was a header for the Communications section (See p. 276).

June 1970. A new feature entitled, "Periodicals on Parade," was started with quotes from current articles of interest.

December 1970. This was a special issue on "Is Man Only a Complex Machine?" with a related back-cover cartoon by Annie Bien. For the first time, this issue showed the new subtitle for the *Journal*: "An evangelical perspective on science and the Christian

faith." This continued as the subtitle until it was adopted as the official title over a decade later.

June 1971. This issue started with a five-point summary of the purpose of the *Journal* for the conservative Christian community, the liberal Christian community, the nonscientifically-trained laypeople, the non-Christian professional scientist, and the evangelical Christian scientist. In connection with an article on "Evangelical Theology and Technological Shock" by Bernard Ramm, Annie Bien drew a cartoon likening shopping for genetic features to supermarket grocery shopping. An active Communications section produced many feedbacks. In this issue was one that every Editor loves to hear:

> I find the *Journal* too good nowadays. I feel like a caged lion. Practically every article makes me want to respond or have a three day discussion on the problem (W. F. Campbell, 23 [1971]: 76).

December 1971. Like many issues, this one also had a special topic: "Creation and/or Evolution." It was introduced by an editorial, "We Believe in Creation," which has remained a standard summary for this issue in subsequent years.

March 1972. This issue featured a special article in which H. Harold Hartzler reminisced about thirty years of ASA. Again the Communications response warmed an Editor's heart:

> I am impressed with this *Journal,* and I am giving this subscription to my father ... I suggest that advertisement and sample copies be sent to every clergyman in America. It is time we faced the issues head on with some intelligent and rational thought (E. B. Stetson, 24 [1972]: 39).

June 1972. A photo of the 1971 ASA Annual Meeting was included. In this issue, I instituted the category, "Dialogue." Two authors with a difference in conviction agreed to enter into a dialogue together. Before publication, each one wrote a defining statement, each one read the other's statement and wrote a response, and each one read the other's response and wrote a rebuttal. Then these six inputs were assembled and published together in the same place in the same issue of the *Journal.* The first Dialogue to appear in print was "Inerrancy, Revelation and Evolution" (June 1972) followed by others, such as "Paleontology and Evolution" (December 1972) and "Is There a Christian Basis for a Sexual Revolution?" (June 1974).

September 1972. Native evangelist John Dare contributed an article, "Evangelism in India." I followed up on this personally. As a result, over the past twenty-five years, I have supported the work in Bangalore which he started, his widow carried on, and her co-worker, Mrs. V. Murthy, continues today.

December 1972. This issue marked the initiation of the first full-time ASA Executive Secretary, William D. Sisterson, succeeding H. Harold Hartazler. A special feature, "The Torch Passes," honored Hartazler for his service to ASA through the years.

March 1973. For the first time, the "Contents" of the *Journal* moved from the front cover to the back cover. Subsequently the front cover featured special headlines or photos.

June 1973. A special tribute to Paul Tournier and a photo of the 1972 Annual ASA Meeting were highlighted in this issue.

September 1973. It was described as "A Vital Message for all Readers" and was illustrated by a cartoon on the cover by Annie Bien (Fig. 4). The cartoon pictured a bridge between the scientific and Christian communities, and raised the question, "Why isn't there somebody on the bridge?" The editorial called ASA members to live actively as a "bridge over troubled waters." It is only they who know personally what it means to be both a member of the Christian community and of the scientific community. In addition, readers were called upon to pledge financially to the support of such a venture. The same issue ventured out into troubled waters by running a special feature titled, "Would You Give This Woman an Abortion?" with six case histories (taken from *Abortion: The Personal Dilemma* by R. F. R. Gardner, Grand Rapids, MI: Eerdmans 1972) printed in special boxes throughout the issue. A final box showed how Christian groups had voted in the past.

December 1973. This issue featured a treatment of "Catastrophism" by Velikovsky, two photos of the

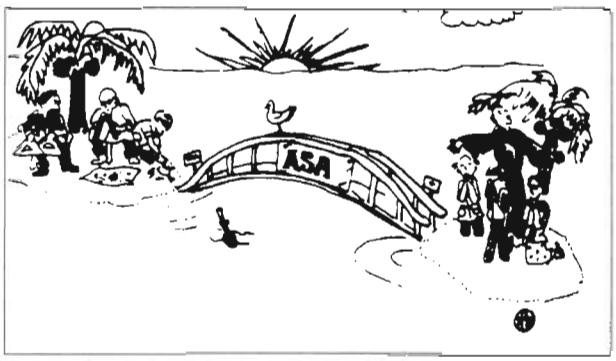

Fig. 4. This cartoon by Annie Bien appeared on the cover of the *Journal,* September 1973. It pictures a bridge between the scientific and Christian communities, and raises the question, "Why isn't there somebody on the bridge?"

Annual ASA meeting in 1973, and the last of Annie Bien's artwork.

March 1974. In this issue, I introduced a new format for the inside front cover of the *Journal*.

September 1974. A new section, "The Student Corner," featuring brief papers written by university students was introduced.

March 1975. The first of several subsequent front cover photos appeared. The first was of a mountain peak seen over a tree-rimmed lake, with the verse, *"Where were you when I laid the foundation of the earth?"* Job 38:4.

March 1976. The front cover showed the almost exponentially increasing membership of the ASA after 35 years of existence (on the year of the bicentennial of the USA). I started my series of articles on "Science and the Whole Person." Also, two new art editors, Darwin and Valley Hennings, joined our staff and introduced the new Communications and Book Reviews headings as shown on pp. 284 and 294 respectively.

December 1976. The front cover featured a creative drawing, "What is man?" by the Hennings.

March 1978. A separate category for Communications was introduced, separating them from "Letters to the Editor."

June 1978. This issue featured a special symposium on the Recombinant DNA controversy. The cover was one of the most creative (and controversial), drawn by Consulting Artists for the *Journal*, Darwen and Valley Hennings. It showed a mouse/carrot genetic variation (Fig. 5). The Hennings left the *Journal* staff in December 1978.

Fig. 5. The controversial June 1978 front cover showed a mouse/carrot genetic variation.

March 1979. The Thirtieth Anniversary of the *Journal* was marked with a *Journal* history on the opening pages and a photo of F. Alton Everest and Peter Stoner. A special feature was a series of "Christian Answers on Homosexuality."

December 1979. A special Festschrift for Bernard Ramm was featured.

September 1980. This issue covered ten topics.

March 1981. A new series, "Reflections on the Practice of Outworn Creeds," by Walter Thorson began.

December 1983. My final issue appropriately had a photo of Hoover Tower through the trees of the Stanford campus, and the verse: *"Wisdom is the principal thing; therefore get wisdom; and with all thy getting get understanding"* Proverbs 4:7, 10.

Major topics of each issue covered a wide range: e.g., Economics (March 1977), Creation/Evolution (June 1977), Stewardship of Natural Resources and Homosexuality (September 1977), Philosophical Challenges (December 1977), Health, Nutrition and Medicine (September 1978), Science vs. Miracles (December 1978), Mind/Matter (December 1981), Social Sciences (June 1982), I.Q. (December 1982), and Unity in Creation (March 1983).

Wilbur Bullock, Editor (1984–1989)

It was with some apprehension that I agreed to become the editor of the *Journal of the American Scientific Affiliation* in 1984. My apprehensions were partly due to my limited experience. While I had served on two editorial boards for scientific journals, I was never the editor. Furthermore, I was following in the footsteps of Richard Bube, who had carried on a fantastic, almost one-man operation in overseeing the many functions involved in the publication of an interdisciplinary, scholarly journal. In brief, this was a real challenge!

Several factors, however, contributed to a rewarding six years. Most helpful to me was the division of the labors of this work by the establishment of the position of "managing editor" to carry out the critical work of corresponding with authors, reviewers, and publishers. During my time as editor, Ruth Herr, Ann Woodworth, and Nancy Hangar carried out these functions in a most helpful and efficient manner. In addition, their location in the Ipswich office—a brief one-hour drive from Durham, New Hampshire—allowed for the periodic consultations at the critical period of each issue of the *Journal*. At times these visits included helpful meetings with

Executive Director Bob Herrmann and the Executive Council of the ASA.

As I indicated in my first editorial (March 1984), I aimed to continue the goal of our journal: "to present evangelical perspectives in a way that will be professionally competent and, at the same time, understandable to people from other sciences." In addition, we—at least sometimes—aimed to present science to pastors and church members and our Christian faith to scientists. A further aim of the *journal* (well-observed by Editor Bube) was to present a diversity of evangelical views on some of the controversial issues involved in "perspectives on science and Christian faith." While our objective was to do this with "gentleness and reverence" (1 Peter 3:15, 16), it was occasionally a challenge to practice the calmness and understanding we aim for in our journal. Two issues proved particularly challenging in this respect.

1. An issue of Christian against Christian was the emotional furor stimulated by Gareth Jones' book, *Brave New People* (1984). Franky Schaeffer, Gary North, and others condemned Jones—and IVP—for his supposed views on abortion and eugenics because he didn't agree with them 100%. Some even questioned Jones' salvation. These critics failed to demonstrate "gentleness and reverence" and some of Jones' statements were distorted and/or misquoted. I believe that we made a positive contribution to this controversy by the publication of Dr. Jones' paper, "Coping With Controversy: Conflict, Censorship and Freedom Within Evangelicalism" (March 1988) as well as several letters from *Journal* readers.

2. An issue that involved a confrontation with secular scientists was the reaction of some science publications to our ASA booklet, *Teaching Science in a Climate of Controversy*. A distortion of this ASA attempt to present an honest middle ground appeared in the *Science Teacher* in which nine scientists negatively distorted and criticized the ASA booklet in an article entitled: "Scientists Decry a Slick New Packaging of Creationism." Replies to this and other criticisms of the ASA booklet were published in the September 1988 issue.

Our present editor has continued this ASA approach to controversial subjects, subjects that involve more complicated solutions than the simple either/or answers that many people would like. The interrelationships of science and Christian faith will continue to challenge scientists, theologians, and laypeople. *PSCF* is an important vehicle for meeting the challenge in an honest and godly manner.

John W. Haas, Jr., Editor (1990–1999)

The electronic revolution of the '90s has made radical changes in the way that manuscripts are handled and the journal is produced. It will not be long before there is a seamless transition via internet from the author to the ASA office to reviewers and then back to the office for editing and incorporation in an issue via desk-top production. The final transmission is to our Pennsylvania publisher for printing and distribution to our readers. In the process, many e-mail communications will be exchanged. What will not change is the difficulty involved in turning down a paper and (in some cases) the task of producing timely reviews.

Lyn Berg is a savvy, exacting, and *permanent* Managing Editor—a welcome change in the light of a rapid-fire succession of three Managing Editors in the first few years of my tenure. Book Review Editor, Richard Ruble, has been a faithful colleague. I appreciate the contributions of authors who offer their manuscripts—in some cases, with the hope that their work will not appear posthumously! The almost two years between receipt and publication of manuscripts discourages authors and diminishes the timeliness of *PSCF*. Perhaps alternate publication on the ASA web page would cut the bottleneck. The new millennium will see our web page as the major public face of the ASA. I thank those who have given so many hours in the review of manuscripts. The passing of W. Jim Neidhardt was a loss of one on whom I had greatly depended.

The major cosmetic change in this decade has been the conversion to "perfect" binding (Dec. 1990). Stand-out issues include the ASA Fiftieth Anniversary issue (Dec. 1991), the issue devoted to discussion of Intelligent Design and Theistic Science (Sept. 1997), and, as an example of good balance, that of June 1993. Recent innovations are the "Young Scientist Corner" and "News and Views." The working arrangements with Executive Directors, Bob Herrmann and Don Munro, and nine Executive Councils have been cordial and affirming.

Conclusion

The *Journal* began with the desire to deal with science-faith issues important in the late 1940s—a seventy-five-member organization spread over a huge land mass. Engineers, chemists, biologists, mathematicians, and a sprinkling of biblical scholars, philosophers, and social scientists sought to come to grips with issues that had challenged the greatest minds since the ancient Greek philosophers. Above all, the literal Bible and the historic Christian

faith were to be defended against science-based attack. It was assumed that the Bible and nature, properly understood, would not be in conflict. The increasing numbers of evangelicals emerging from post-WWII graduate schools were actively recruited to the new organization to join the battle against unbelief. All too quickly, it became clear that the issues were not easily resolved; even evolution would creep in. The "Harmonious Dissonance" of the early days would erode.[18]

Today, it is clear that evangelicals will not allow scientists to be the spokespeople on science-faith issues. Instead, clerics and pundits with a critique of science vie to catch the evangelical ear. The ASA seems to be one more element in a plethora of voices on the science-religion front. New educational strategies are needed to help students and the person in the pew see the wisdom and majesty of God in creation. Clamorous disputes over fine points of interpretation and lack of humility are impediments to our vision. We must continue to actively bring our faith to bear on emerging issues of the day. ✯

Appendix I

Editors	Affiliations During Editorship
• Marion Barnes (1949–1951)	Research Chemist, Lion Oil Company
• Delbert N. Eggenberger (1951–1962)	Research Physicist, Argonne National Laboratory
• David O. Moberg (1962–1964)	Professor of Sociology, Bethel College, St. Paul, MN
• Russell L. Mixter (1965–1968)	Professor of Biology, Wheaton College
• Richard Bube (1969–1983)	Professor of Material Science, Stanford University
• Wilbur Bullock, (1984–1989)	Professor of Biology, University of New Hampshire
• John W. Haas, Jr., (1990–1999)	Professor of Chemistry, Gordon College

Notes

[1]The Victoria Institute or Philosophical Institute of Great Britain was established in 1865 to counter the increasing antireligious emphasis of the British Association for the Advancement of Science. The original journal, *Journal of the Transaction of The Victoria Institute,* became *Faith and Thought* in 1988. In 1989 it was joined with *Science and Christian Belief,* the journal of our sister organization, Christians in Science. The heyday of The Victoria Institute in the late Victorian period saw a distinguished membership of amateur and professional scientists, clergy, and political figures. The ASA founders framed the organization in part on this venerable institution.

[2]F. Alton Everest, *The American Scientific Affiliation: Its Growth and Early Development* (privately printed, 1986), 93, 97. See also 100–4.

[3]I suspect that our web site and listserve will soon become the most public outreach of the ASA.

[4]*Journal of the ASA (JASA)* 1, no. 1(1949):3.

[5]Richard Bube's extended series of columns "Penetrating the Word Maze" ran from June 1988 through December 1990.

[6]Editorial, "Expanding Horizons in a Shrinking World," *JASA* 16, no. 1 (1964): 3.

[7]Ibid. [Today "*confrontation*" might be better seen as "*interaction,*" (Jack Haas, ed.)]

[8]Possibly the most pertinent is F. Alton Everest, "Challenges Before the American Scientific Affiliation," Ibid., 10–1. See also Henry Weaver Jr., "Critical Issues Modern Science Poses for the Christian Church Today," Ibid., 4–7; Mary Key, "The Role of the ASA," *JASA* 16, no. 2 (1964): 32; Editorial, "The Past Is Prologue," Ibid., 33–5, and David O. Moberg, "Ethical Decisions of Christians in Science: Introduction to a Symposium," *JASA* 14, no. 3 (1962): 66–7.

[9]V. Elving Anderson and David O. Moberg, "Christian Commitment and Evolutionary Concepts," *JASA* 15, no. 3 (1963): 69–70.

[10]See *JASA* 15, no. 4 (1963): 118; and *JASA* 16, no. 1 (1964): 27–31, 59–63.

[11]"Creation Research Society," *JASA* 15, no. 4 (1963): 115.

[12]See Ibid., 118; *JASA* 16, no. 1 (1964): 27–31; and *JASA* 16, no. 2 (1964): 59–63.

[13]"Evolution," *JASA* 14, no. 4 (1962): 126.

[14]Ibid.

[15]Dan E. Wonderly, "Letters to the Editor: Evolution," *JASA* 15, no. 2 (1963): 67.

[16]Kenneth W. Allen, Ibid., 67.

[17]Oscar L. Brauer, Ibid., 67–8.

[18]See Mark A. Kalthoff, "The Harmonious Dissonance of Evangelical Scientists: Rhetoric and Reality in the Early Decades of the American Scientific Affiliation," *Perspectives on Science and Christian Faith* 43, no. 4 (1991): 259–72.

Discussion on the ASA ListServe

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Is "Progressive Creation" Still a Helpful Concept?

Reflections on Creation, Evolution, and Bernard Ramm's *Christian View of Science and Scripture*— A Generation Later

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This article argues that Bernard Ramm's concept of "progressive creation" is still a useful category for interpreting biblical and scientific data relating to origins. After reviewing significant developments since Ramm's 1954 publication in both theological and scientific scholarship, an attempt is made to relate a modified version of Ramm's concept to current discussions of creation and evolution in English-speaking Christianity. It is argued that "progressive creation," which can be distinguished from both "fiat creation" and "theistic evolution," is a category broad enough to encompass both the immanent presence of God working within nature and the transcendent power of God above the laws of nature. Christians working in the life sciences are left free to recognize the variety of ways in which the creative action of God has been operative in the natural order.

In the estimation of one recent historian of science, Bernard Ramm's 1954 book, *The Christian View of Science and Scripture*, "... profoundly influenced the way in which many orthodox Christians answered the questions posed by creation and evolution."[1] Twenty-five years after the book's publication, John W. Haas, Jr., a member of the American Scientific Affiliation, an association of evangelicals in the natural and biological sciences, called Ramm's book "a pivotal event" in the modern history of science and religion.[2]

In his discussion of the biological sciences, Ramm proposed the concept of "progressive creation" as an alternative to both theistic evolution and the "fiat creationism" of the fundamentalists, who understood creation almost exclusively in terms of instantaneous, supernatural acts of God. According to Ramm, progressive creation was the means by which the Spirit of God, as "World Entelechy," brought to pass the divine will in nature. Under the direction of the Holy Spirit, the laws of nature, over a long period of time and through a variety of processes, actualized the plan of God.[3] Because he believed in several acts of sudden, fiat creation in the history of the earth—in view of the discontinuities in the fossil record—Ramm believed that his view was clearly differentiated from theistic evolution. In Ramm's mind, "progressive creation" avoided the arbitrariness of fiat creationism, while preserving its emphasis on the transcendence of God, and also avoided the "uniformitarianism" of theistic evolution, while affirming its emphasis on progress and development.[4]

Ramm expressed the rather grandiose and somewhat naive hope that his concept of "progressive creation" could form the basis of "a new biological synthesis" which would be for biology what the relativity theory was for physics.[5] Quite contrary to

*ASA Member

Ramm's intentions, his proposal sparked a renewal of the "flood geology" and "young-earth creationist" tradition in American fundamentalism—a tradition which Ramm had hoped to lay to rest.[6]

The purpose of this essay is to argue that "progressive creation" is still a useful category for interpreting the biblical and scientific data relating to origins. Of course, much has transpired both in biblical scholarship and scientific research since Ramm published a generation ago. After reviewing significant developments in the theological and scientific areas, I will relate a modified version of Ramm's concept of "progressive creation" to current discussions of creation and evolution in English-speaking Christianity.

Trends in Biblical Scholarship

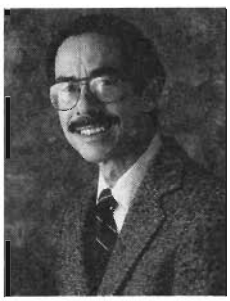
In recent years, biblical scholars have increasingly drawn attention to the fact that the agenda which modern interpreters often brought to the text of the early chapters of Genesis—issues of "science and Scripture"—are, at best, secondary to the primary interests of the biblical writers. Evangelical scholars, such as Gordon Wenham, stress that Genesis is to be seen primarily against the background of its ancient Near Eastern religious environment. According to Wenham, Genesis 1–11 is best seen as a "tract for the times," challenging the ideas of the polytheistic religions of the ancient Near East about the nature of God, the world, and humankind. Genesis is concerned with affirming the unity of God in the face of polytheism and the justice of God rather than caprice; "scientific" issues in the modern sense of the word are only indirectly related to the primary purpose of the text.[7]

Similarily, Gerhard Hasel has argued for the "polemic nature of the Genesis cosmology."[8] A primary concern of the text is to criticize the polytheistic nature religions of the ancient Near East which identify the sun, moon, stars, and forces of nature as deities. The Genesis cosmology forcefully asserts that the heavenly bodies are not gods and goddesses to be worshiped, but creatures of the one, holy God who created the world and rules it according to his righteous laws. The Genesis cosmology represents a complete break with the mythological cosmologies of Israel's neighbors in the Fertile Crescent.[9]

Shortly after Ramm published *The Christian View*, the evangelical theologian J. I. Packer made the valuable observation that interpreters must draw distinctions between "... the subjects about which the Scripture speaks and the terms in which it speaks of them." The writers of Scripture spoke about the natural world in an ordinary, nontechnical language shared with their contemporaries. Their concern was not primarily the inner structure of the world and of humans, but with the *relationship* of both to God.[10]

This point concerning the "relational" rather than the "scientific" focus of Genesis has also been made in another way by British geneticist R. J. Berry. Since the end of the eighteenth century, in Berry's view, liberal and conservative interpreters alike have erred in approaching the biblical accounts of creation "as if they were primarily concerned with origins rather than with relationships."[11] The preoccupation with questions of origins has deflected attention away from the primary biblical concerns, namely, the relationship of nature to God and humanity's proper relationship to the creation. As a result, evangelicals have failed to develop an adequate theology and practice of environmental stewardship.

Discussions of "creation and evolution" have at times suffered from a lack of attention to the range of possible meanings of the biblical terms used to describe God's creative work. For example, the primary sense of the crucial word "*bara*" ("create"), used 49 times in the Old Testament and ten times in Genesis, is that through God's command something comes into being that had not existed before. The word is used exclusively of divine action, and implies a creative work that is beyond human power. Since the word never occurs with the object of the



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material, the primary emphasis of the term is on the newness of the created object. The concept of "*ex nihilo*" creation, while it may be implied in a given case, is not necessarily inherent in the meaning of the word.[12]

It is important to note that the focus of such a biblical term for creation as *bara* is not so much on the physical *processes* used by God as on the *results* of the divine action and the *relationship* of these results to the redemptive purposes of God. Modern science is primarily concerned with physical processes; Scripture is primarily concerned with results and relationships.[13] The word *bara* can be used to refer to a clearly supernatural, *ex nihilo* creative act which brings the universe into being (Gen. 1:1), or to the divine power working through natural processes to "create" the winds (Amos 4:13), or to bring animals to birth through the normal processes of gestation (Ps. 104:30). Whether God's creative work in any given case involves natural or supernatural means, or long periods of time rather than instantaneous effects, cannot be judged in advance, but must be determined in light of the particular biblical texts and specific features of the natural order. This distinction between *process* and *results* will be noted again in the further reflections on "progressive creation" and "theistic evolution" in the closing section of this paper.

Scientific Developments since Ramm

The biological sciences have developed dramatically since Ramm wrote *The Christian View of Science and Scripture* in 1954.[14] Some of the most explosive growth has been in the disciplines of genetics and molecular biology. The discovery of the double-helix structure of the DNA molecule by Watson and Crick in 1953 and the subsequent deciphering of the genetic code were watershed events in the history of biology, opening up new frontiers of scientific research.[15] Biologists were able to study living forms not only externally, but internally as well, at the genetic and molecular levels.

According to Stephen Jay Gould, the most important event in evolutionary biology during the 1970s was the "development of electrophoretic techniques for the routine measurement of genetic variation in natural populations."[16] These new techniques allow biologists to compare the sequences of the bases in the chains of genetic material (DNA and RNA) and the amino acid sequences of proteins which are characteristic of each organism. The quantitative differences in these sequences are interpreted as a measure of the degree of the remoteness of two organisms from a common ancestor. These discoveries in genetics and molecular biology provide new ways for biologists to check hypotheses about the relationships between living forms previously limited to studies of morphology and embryology.[17]

During the last twenty years, paleontologists have made important new discoveries, especially in the fossil record of the vertebrates. New groups of jawless fish, sharks, amphibians, and dinosaurs have become known, and major transitions between amphibians and reptiles, reptiles and mammals, and dinosaurs and birds have been extensively studied.[18]

In the 1970s two paleontologists, Niles Eldredge of the American Museum of Natural History and Stephen Jay Gould of Harvard University, sparked a major controversy in evolutionary biology and paleontology with their concept of "punctuated equilibria." According to this view, evolution proceeds in "fits and starts" rather than in small, gradualistic Darwinian steps. Evolution proceeds very rapidly when new species are being formed, and then these forms typically remain unchanged for long periods of time ("stasis"). According to the "punctuationists," the well-known gaps in the fossil record are real, and are to be expected if speciation occurs rapidly in small, geographically isolated populations that would leave few fossil remains.[19] Defenders of the orthodox Darwinian gradualism argue that the "punctuationists" have overstated their case. The coarse time resolution of most fossil studies biases the observer toward a perception of stasis. Some cases seem to fit the "punctuationist" model fairly well, but other groups, e.g., the mammals, seem to have adapted and changed in very gradual and piecemeal ways.[20]

As late as 1953, when paleontologist George Gaylord Simpson published his classic book on macroevolution entitled *The Major Features of Evolution*,[21] the major evolutionary transitions between the larger taxonomic groups were still, for the most part, inadequately documented from the fossil record.[22] Darwin himself was quite aware of the major "gaps" in the fossil strata and attributed them to the "imperfections" of the geological record.[23] Since the 1950s, new fossil discoveries have given evidence of some transitional forms that are clearly intermediate between fish and amphibians and between reptiles and mammals.

Beginning in 1952, Jarvik and other paleontologists have given extensive attention to a primitive extinct amphibian, *Ichthyostega*, discovered in the sedimentary rocks of eastern Greenland. *Ichthyostega* had anatomical features which were intermediate between the more advanced amphibians and the

crossopterygian (lobe-finned) lung fish from which amphibians are believed to have evolved. The extinct lung fish, *Eusthenopteron* and *Ichthyostega* (see Fig. 1 below), share many common features, including the ability to breathe air, the shape of the body, and the skeletal features of the upper limbs and skull. *Ichthyostega* had a genuine fish-like tail, its skin was protected by small fish-like scales, and its compressed body shape was typical of fish. Yet in spite of its strange mixture of fish and amphibian characteristics, *Ichthyostega* was clearly a full-fledged tetrapod and can be placed among the early amphibians, of which it is a primitive representative.[24]

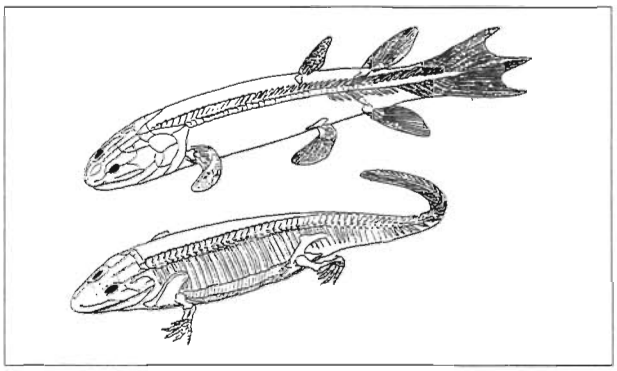

Fig. 1. A comparison of the skeletons of the lobe-finned fish *Eusthenopteron* (above) and the primitive amphibian *Ichthyostega* (below). Reprinted with permission from Colbert and Morales, *Evolution of the Vertebrates*, 4th ed. (New York: John Wiley & Sons, 1991), 69.

Even more recently Per Ahlberg, a paleontologist working at the Natural History Museum in London, has reported new findings related to *Panderichthys*, an extinct lobe-finned fish. His findings show that *Panderichthys* had a mosaic of fish-like and amphibian-like characteristics.[25] These fossils indicate that changes in the skull roof, braincase, and fins occurred in a relatively rapid period (geologically speaking) of 9–14 million years, and provide further evidence of the transition between the strictly aquatic lobe-finned fish and the four-legged amphibians.[26]

The fossil sequence from the reptiles to the earliest mammals "... is the most fully documented of the major transitions in vertebrate evolution," according to Robert Carroll, a paleontologist at McGill University.[27] The transformations in the fossil record can be traced over a period of 150 million years, from "small, cold-blooded scaly reptiles to tiny, warm-blooded, furry mammals."[28] Here it is a case not of "gaps in the fossil record," but rather an abundance of riches. T. S. Kemp of the University Museum and Department of Zoology at Oxford concurs: "This is the one known example where the evolution of one class of vertebrates from another class is well documented by the fossil record."[29]

Most paleontologists agree that the ancestry of the mammals is to be sought among a group of extinct mammal-like reptiles known as cynodonts.[30] The fossil record of mammal-like reptiles (synapsids) is the most complete of any group of terrestrial vertebrates with the exception of the mammals themselves.[31] By way of illustration, we may examine the case of *Cynognathus*, an extinct cynodont about the size of a large dog, displaying a blend of reptilian and mammalian characteristics (see Fig. 2 below).

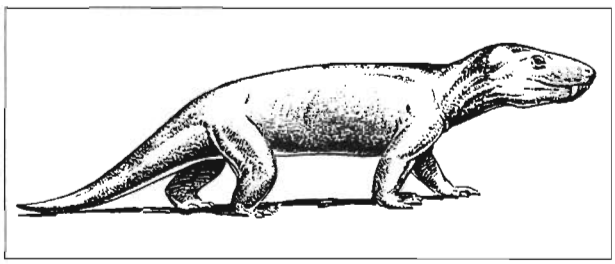

Fig. 2. Cynognathus, an extinct mammal-like reptile. Reprinted with permission from Colbert and Morales, *Evolution of the Vertebrates*, 4th ed. (New York: John Wiley & Sons, 1991), 126.

Cynognathus had a rather large skull that was dog-like in appearance. Its teeth were differentiated and specialized, unlike the undifferentiated teeth of a reptile. Small, peg-like incisors were adapted for biting and nipping, and the post-canines were suited for chewing food—an indication that this animal cut its prey into small pieces before eating it, rather than swallowing it whole as do many reptiles. The vertebral column was differentiated into cervical, dorsal, and lumbar regions. To increase the efficiency of locomotion, the limbs were held beneath the body with the knee pointing forward and the elbow pointing backward. These and other specializations of *Cynognathus* show that it was an active, carnivorous reptile that was approaching a mammalian stage of development in many respects.[32] *Cynognathus* is only one example from a very large class of extinct tetrapods that display characteristics that are intermediate between the reptiles and the mammals.

Other *living* forms—the monotremes, or egg-laying mammals of Australia—also exhibit features intermediate between reptiles and the more advanced mammals. The echidna and the platypus or duckbill (see Fig. 3, p. 254) are very primitive mammals that reproduce by laying eggs and suckle their young on milk secreted by modified sweat glands.

The skeletons and soft anatomies of these animals display certain reptilian characteristics.[33] The cervi-

cal ribs are not fused, and certain reptilian characteristics can be seen in the skull. The urogenital system and rectum open into a common cloaca as in reptiles rather than separately as in mammals. In many respects, monotremes, such as the platypus and the echidna, give, according to Colbert and Morales, excellent living examples of "mammals intermediate in their stage of evolution between the mammal-like reptiles and the higher mammals."[34]

Any discussion of intermediate forms in the geological record must include the fossil evidence of the hominid forms believed to be the precursors of modern *Homo sapiens*.[35] Much new evidence has become known since Ramm wrote in 1954. The hominid fossil record shows that the anatomical and behavioral characteristics that we associate with the "human" have emerged and developed over long periods of time. For example, the *Australopithecines*, extinct hominids that flourished in Africa approximately 3–4 million years before the present, were capable of upright walking, like modern humans, but in brain capacity and other anatomical features were more like chimpanzees. The *Australopithecines* in these respects are intermediate forms between modern man and the great apes. As the hominid fossil record is followed over a four-million-year period from the *Australopithecines* to *Homo habilis* to *Homo erectus* to *Homo neanderthalensis* to modern *Homo sapiens*, one can see the changes in brain capacity, dentition (tooth structure), and skeletal structures that move from forms that are more apelike to those more characteristic of modern humans. This evidence of transitional forms in the fossil record, together with evidence from comparative anatomy and molecular biology,[36] leads modern biologists and anthropologists to believe that modern humans and the great apes shared a common ancestor some five million years ago, probably on the African continent.

One of the most notable features of the fossil record is the sudden, almost "explosive" appearance

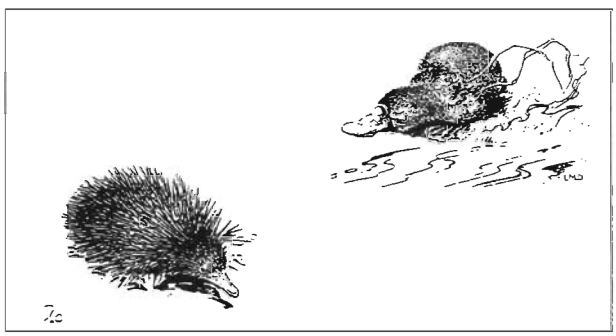

Fig. 3. Platypus (above) and Echidna (below). Reprinted with permission from Colbert and Morales, *Evolution of the Vertebrates*, 4th ed. (New York: John Wiley & Sons, 1991), 240.

of the major phyla during the late Precambrian and early Cambrian periods. Since then extensive changes have occurred *within* the phyla, but few new animal phyla have appeared. It is also quite notable that, according to Eicher and McAlester: "There is no fossil record of the origin of these phyla, for they were already clearly separate and distinct when they first appeared as fossils."[37] Complex, multicellular organisms such as the trilobites, corals, and crustaceans appear fully formed in the fossil record with no obvious ancestral forms.

Various explanations have been offered for the "Cambrian explosion," which has been called the "Big Bang" in the history of life on earth. Some scientists have alleged that increases in oxygen levels in the oceans could have promoted the rapid development of life. Other suggestions have included increases in the calcium or phosphorous content of the oceans, enabling the rapid development of organisms with skeletons; the advent of predators providing selection mechanisms for diversification; and the evolution of regulatory genes making the rapid appearance of new body plans possible.[38] All these suggestions are rather speculative, and no single explanation has won general acceptance within the scientific community.

Before 1947 almost nothing was known about the nature of multicellular life prior to the Cambrian. During that year an extensive fossil deposit of soft-bodied organisms, dating to about 640 Myr before present, was discovered in the Ediacara Hills of southern Australia. These fossils, which have since become known as the "Ediacara fauna," fall into four main categories: jellyfish, soft corals, segmented worms, and other organisms of unknown affinities (see Fig. 4).[39] These animals did not possess shells or skeletons.

In recent years, a rich and varied fauna from the lower Cambrian-Precambrian boundary has been discovered in Siberia. These tiny fossils, many of which have phosphatic shells, are generally known as the "Tommotian fauna" (see Fig. 5). Similar fossils have since been found in Australia, England, and Scandinavia. Many of these forms continue up into the lower Cambrian, where they appear with the trilobites.[40]

It is not clear how either the soft-bodied Ediacara fauna or the small, shell-bodied Tommotian fauna could plausibly be seen as ancestral to complex organisms such as the trilobites. In the words of E. N. K. Clarkson of the University of Edinburgh, these fossils testify to "an explosive development of life at this most critical point in life's history."[41]

Some of the most extensively studied animals from the Cambrian period are the trilobites, hard-shelled creatures somewhat like modern horseshoe crabs, that are abundantly represented in the fossil record from the lower Cambrian, 570 Myr before present, until their final extinction during the Permian, about 250 Myr ago. The trilobites appear in the fossil record abruptly and fully formed. Their origins are a major mystery in the history of life. According to H. B. Whittington, a leading authority in this field, "unequivocal answers cannot be given" to the questions of how and where the trilobites arose; no transitional series of fossils have been found.[42] Candidates for the presumed ancestors of the trilobites have been found among the annelid worms or the Ediacara genus Spriggina (see Fig. 4), but as Clarkson has admitted, "this is only speculation."[43]

Since the 1960s, scientists have extensively studied the remarkable compound eyes of the trilobites (see Fig. 6).[44] They are the most ancient visual system known in the entire history of life. Like the eyes of insects and crustaceans, these are compound eyes

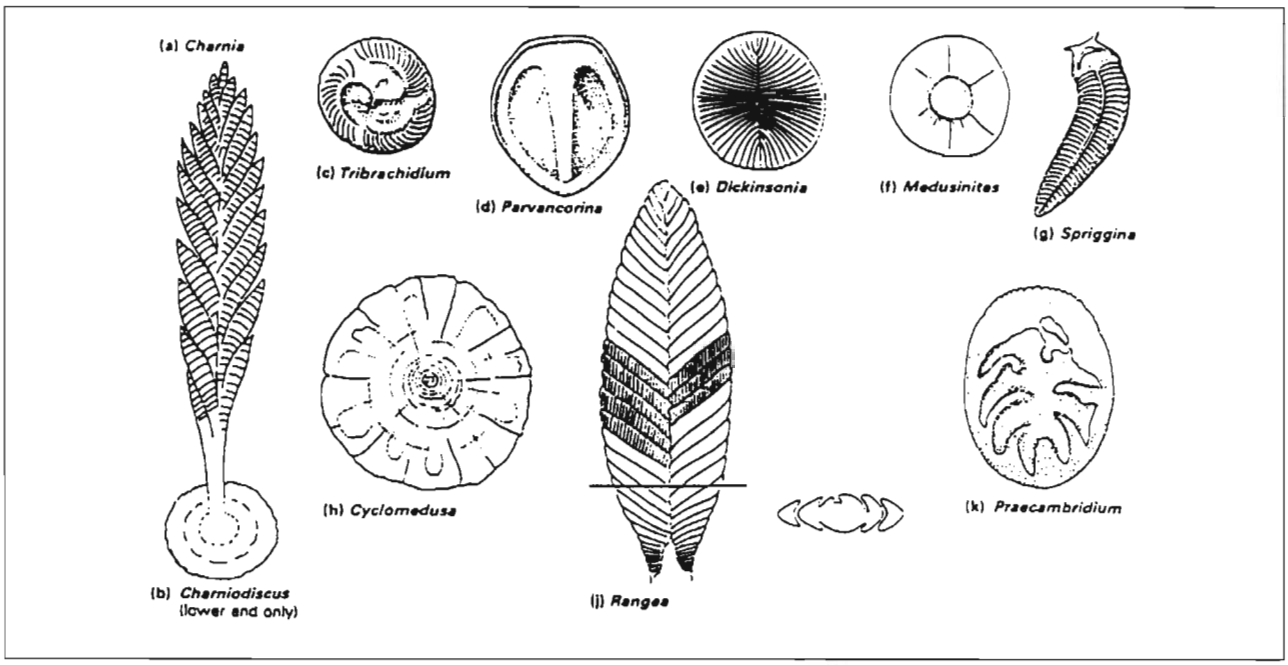

Fig. 4. Precambrian Ediacara fauna. From Clarkson, *Invertebrate Palaeontology and Evolution*, 2d ed. (London: Allen & Unwin, 1986), 49. Reprinted with kind permission from Kluwer Academic Publishers.

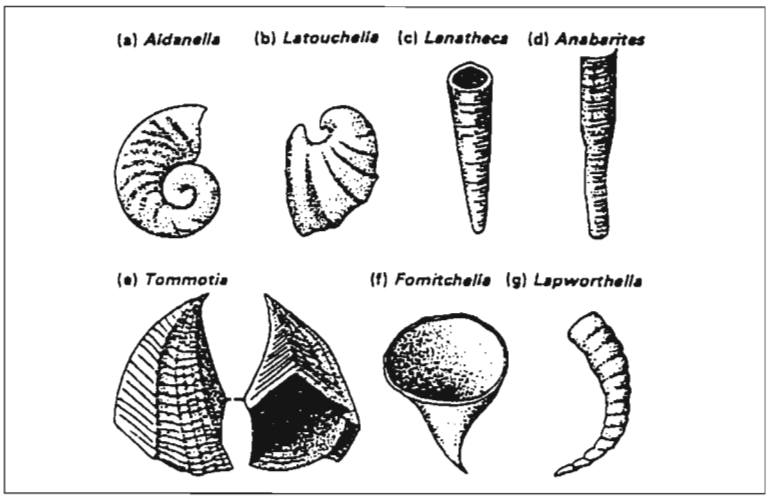

Fig. 5. Tommotian fauna from Siberia. From Clarkson, *Invertebrate Palaeontology and Evolution*, 2d ed. (London: Allen & Unwin, 1986), 52. Reprinted with kind permission from Kluwer Academic Publishers.

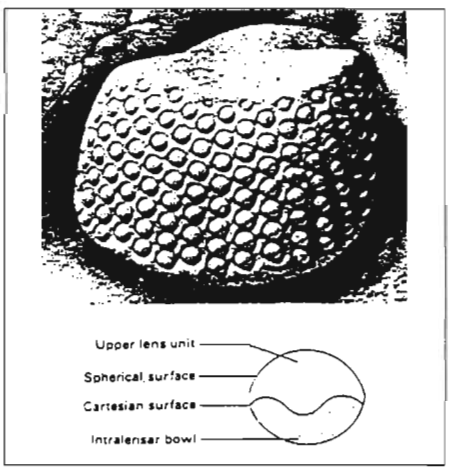

Fig. 6. Trilobite eyes and their structure. Reprinted with permission from R. Boardman, ed., *Fossil Invertebrates*, (Oxford: Blackwell Science Ltd., 1987), 227.

composed of radially arranged visual units that give a wide-angled visual field. The number of optical elements in these compound eyes could range from about one hundred to more than fifteen thousand in a single eye. It is believed that with such eyes the trilobite could form an image of a nearby object and even estimate its distance. The problem, from a purely evolutionary perspective, is how to explain the origin of such a complex and abruptly appearing organ through a process of small, gradual changes and natural selection. No living forms prior to the trilobites give evidence of having even rudimentary eyes, much less complex eyes like those of the trilobites.

When Ramm published *The Christian View*, experimental research on the origins of life was in its infancy. In 1953 Stanley Miller and his associates at the University of Chicago had just completed the first successful prebiotic simulation experiments, synthesizing a variety of amino acids by passing electric sparks through a mixture of methane, ammonia, hydrogen, and water vapor.[45] Since Miller's pioneering work, four decades of intensive chemical experimentation have shown that the synthesis of amino acids is rather easy to achieve, but the prebiotic synthesis of the more complex molecules necessary for life is extremely difficult.[46] The basic problem facing origins-of-life researchers is that life requires the presence of very complex molecules (proteins, enzymes) for metabolism, and very complex molecules (RNA, DNA) for replication, and these molecules must occur together.[47] The enormous difficulties of creating such molecules under conditions similar to those obtaining in the early earth led Francis Crick, the co-discoverer of the structure of the DNA molecule, to propose the bizarre hypothesis ("directed panspermia") that life was sent to earth by an advanced civilization in the form of bacteria on a spaceship.[48]

Some leading researchers in this field believe that RNA was the original molecule in the origins of life, somehow initially serving both as a metabolic catalyst and as an informational "template" for replication. Chemist Manfred Eigen has synthesized an RNA molecule with the aid of an enzyme extracted from some living bacteria, and Leslie Orgel has synthesized RNA from simpler molecules using a form of RNA as a template. But neither Eigen nor Orgel have been able to synthesize RNA without the presence of either an enzyme or a template, as would have been the case under the actual conditions of the prebiotic earth.[49]

Other researchers, such as A. G. Cairns-Smith, a chemist at Glasgow University, believe that the problems of life originating in the primeval ocean are overwhelming, and have proposed as an alternative the "clay hypothesis." According to Cairns-Smith's speculations, the first organisms on earth had a different biochemistry from that of life today, and evolved through natural selection from inorganic crystals. Complex molecules were built up on a substrate of clay, which in some fashion was presumably able to supply the information needed for replication now provided by RNA and DNA.[50] In one recent experiment, researchers were able to build up long molecules on mineral surfaces, but these molecules were not able to replicate themselves, as in a living system.[51]

It would seem that the creation of life in the laboratory, if it is indeed possible, is a long way in the future. While investigators have proposed many models for the origins of life, Leslie Orgel, a leading authority in the field, has admitted that "... evidence in favor of each of them is fragmentary at best." In a somewhat somber prognostication, Orgel concludes: "The full details of how ... life emerged may not be revealed in the near future."[52]

Some Concluding Reflections

The foregoing survey has shown that momentous discoveries have occurred in the life sciences since Bernard Ramm wrote over a generation ago. Nevertheless, it remains my conviction that Ramm's concept of "progressive creation" is still a helpful way of interpreting both the biblical and scientific data relating to origins. "Progressive creation," understood as an alternative to "fiat creation" and "theistic evolution" incorporates the elements of truth in both, and means that *God's creative action has occurred over long periods of time through a variety of means.*

The emphasis on "a variety of means" calls attention to the fact that the focus of the biblical terminology of creation is on the results of God's action, and the relationship of those results to the divine purpose, rather than on the details of the processes used by God to achieve these results. "Fiat creationism" in both its older and more recent forms in American fundamentalism is based on an unnecessary dichotomy between natural and supernatural processes as possible methods of creation.[53] God is free to create through natural or supernatural means, and by rapid processes or over long periods of time; no single type of process can, in an a priori fashion, be identified as uniquely suited to the divine purpose.[54]

"Progressive creation," like "theistic evolution," recognizes that a Christian theory of origins must

acknowledge and incorporate the evidence for the evolutionary changes that have occurred in the history of life. In some cases, such as the reptilian-mammalian transitions in the fossil record noted above, the evidence for macro-evolutionary change is stronger than Ramm supposed, and "theistic evolution" would seem to be an appropriate terminology.[55] In other cases, however, the evidence for discontinuity and the rapid emergence of novelty in the history of nature is strong, and the language of "progressive creation" calls attention to these facts.[56] Notable cases in point here would be the *ex nihilo* creation of space-time, matter, and energy at the "Big Bang"; the emergence of life from inanimate matter over 3.5 billion years before the present; the explosive appearance of the major animal phyla at the Precambrian-Cambrian boundary some 570 million years ago; and the sudden appearance of art and other expressions of behaviorally modern humanity, some forty thousand years ago.

The terminology, "progressive creation," is broad enough to encompass both the immanent presence of God working within the laws of nature and the transcendent power of God above the laws of nature. From this perspective, the Christian working in the life sciences is free to recognize the variety of ways in which God's creative activity has been expressed, in the confidence that the "book of nature" rightly interpreted will ultimately be consistent with the "book of Scripture" rightly understood. ✯

Notes

[1]Ronald L. Numbers, *The Creationists* (Berkeley: University of California Press, 1992), 187.

[2]John W. Haas, Jr., "The Christian View of Science and Scripture: A Retrospective Look," *Journal of the American Scientific Affiliation* 31 (1979): 117.

[3]Bernard Ramm, *The Christian View of Science and Scripture* (Grand Rapids: Eerdmans, 1954), 116.

[4]Ibid., 113, 116.

[5]Ibid., 272.

[6]Numbers, *The Creationists*, 187f. Numbers traces the responses by John C. Whitcomb, Jr., Henry Morris, and the launching of the modern "creation science" movement, signalized by the 1961 publication of Whitcomb and Morris, *The Genesis Flood*, defending (against Ramm) a young earth, a literal six-day creation, and a universal flood as the causal explanation for the earth's major geological features.

[7]Gordon Wenham, *Genesis 1–15* (Waco, TX: Word, 1987), xlv, 1.

[8]Gerhard F. Hasel, "The Polemic Nature of the Genesis Cosmology," *Evangelical Quarterly* 46 (1974): 81–102. The ancient Near Eastern religious context of Genesis, and ancient religious ideas of creation, are masterfully reviewed in Claus Westermann, *Genesis 1–11: A Commentary*, trans. John J. Scullion (London: SPCK, 1984), 19–46, "Creation in the History of Religions and in the Bible." Further helpful discussion of the background and theological purposes of the creation accounts in Genesis may be found in Bruce K. Waltke, "The Creation Account in Genesis 1:1–3: Part I: Introduction to Biblical Cosmogony," *Bibliotheca Sacra* 132 (1975): 25–36.

[9]Hasel, "The Polemic Nature of the Genesis Cosmology," 91.

[10]J. I. Packer, *Fundamentalism and the Word of God* (London: InterVarsity Fellowship, 1958), 96–8.

[11]R. J. Berry, "Creation and the Environment," *Science and Christian Belief* 7 (1995): 21–43 at 21. The references in this article provide a comprehensive review of historical and theological literature relating to environmental issues.

[12]H. Ringgren, "*bara*," *Theological Dictionary of the Old Testament*, Vol. II, eds. G. Johannes Botterweck and Helmer Ringgren, trans. John T. Willis (Grand Rapids: Eerdmans, 1975), 242–9; and Thomas E. McComiskey, "*bara*," *Theological Wordbook of the Old Testament*, Vol. I, ed. R. Laird Harris (Chicago: Moody Press, 1980), 127–8.

[13]In terms of Aristotle's terminology of the four types of causes, modern science, in its concern with the quantitative understanding of physical processes, focuses on "material" and "efficient" causes; the Bible and Christian theology, with its concern for the meaning and purpose of God's creative work, focuses on "formal" (issues of design, designer) and "final" (issues of purpose, teleology) causes.

[14]Surveys of current trends in evolutionary biology may be found in standard texts such as Douglas J. Futuyma, *Evolutionary Biology*, 2d ed. (Sunderland, MA: Sinauer Associates, 1986) and Mark Ridley, *Evolution* (Boston: Blackwell Scientific Publications, 1993). Historical studies of the development of modern biological thought are presented in Ernst Mayr, *The Growth of Biological Thought: Diversity, Evolution, and Inheritance* (Cambridge, MA: Harvard University Press, 1982) and David Young, *The Discovery of Evolution* (Cambridge: Cambridge University Press, 1992). Young traces the historical development of evolutionary thought from the seventeenth century to the present against the background of the growth of the disciplines of botany, zoology, and geology, in a clearly written and helpfully illustrated text.

[15]For the historical development of the discipline of genetics and reviews of basic concepts, see John B. Jenkins, *Genetics* (Boston: Houghton Mifflin, 1975); George W. Burns and Paul J. Bottino, *The Science of Genetics*, 6th ed. (New York: Macmillan, 1989); David Suzuki and Peter Knudston, *Genetics: The Clash Between the New Genetics and Human Values* (Cambridge, MA: Harvard University Press, 1989); and Gunther Stent, *Molecular Genetics: An Introductory Narrative* (San Francisco: W. H. Freeman, 1971). D. J. Weatherall, *The New Genetics and Clinical Practice*, 3d ed. (Oxford: Oxford University Press, 1991) is considered the definitive work on genetics and clinical ethics. The impact of new genetic research on evolutionary biology is discussed in Christopher Wills, *The Wisdom of the Genes: New Pathways in Evolution* (New York: Basic Books, 1989). For the original discovery of the structure of the DNA molecule, see James D. Watson, *The Double Helix: A Personal Account of the Discovery of the Structure of DNA*, ed. Gunther S. Stent (London: Weidenfeld and Nicolson, 1981).

[16]Stephen Jay Gould, *Ontogeny and Phylogeny* (Cambridge, MA: Harvard University Press, 1977), 406.

[17]Colin W. Stearn and Robert L. Carroll, *Paleontology: The Record of Life* (New York: John Wiley and Sons, 1989), 29.

[18]Robert L. Carroll, *Vertebrate Paleontology and Evolution* (New York: W. H. Freeman and Co., 1988), preface. For readable introductions to the field of paleontology, see Stearn and Carroll, op. cit.; Steven M. Stanley, *Earth and Life Through Time* (New York: W. H. Freeman, 1986)—combines historical geology and paleontology; and Richard Fortey, *Fossils: The Key to the Past* (London: Heinemann, 1982) —well-illustrated.

[19]The case for "punctuated equilibria" is argued by Steven M. Stanley, *The New Evolutionary Timetable: Fossils, Genes, and the Origin of Species* (New York: Basic Books, 1981), and by Niles Eldredge, *Time Frames: the Rethinking of Darwinian Evolution and the Theory of Punctuated Equilibria* (London: Heinemann, 1986). This latter work includes as an appendix (pp. 193–223), the original 1972 paper by Eldredge and Gould, "Punctuated Equilibria: an Alternative to Phyletic Gradualism."

[20]Jeffrey Levington, *Genetics, Paleontology, and Macroevolution* (Cambridge: Cambridge University Press, 1988), 407–8. The orthodox, neodarwinian "gradualist" paradigm is also defended by Antoni Hoffman, *Arguments on Evolution: a Paleontologist's Perspective* (New York: Oxford University Press, 1989). It should be noted that this debate is an intramural dispute within evolutionary biology, not an abandonment of the evolutionary paradigm itself.

[21]G. G. Simpson, *The Major Features of Evolution* (New York: Columbia University Press, 1953).

[22]Robert L. Carroll, "Revealing the Patterns of Macroevolution," *Nature* 381 (2 May 1996): 19–20 at 19. Simpson and Carroll were aware, of course, of the famous series of horse fossils documented by Marsh and others in the nineteenth century, and the notable Archaeopteryx, intermediate between the dinosaurs and birds, but had in mind the relative absence of forms clearly intermediate between major groups such as the fish and amphibians, and the reptiles and the mammals.

[23]The awareness of major discontinuities in the fossil record was a significant factor in the development of the "punctuated equilibria" hypothesis by Eldredge and Gould. Today, many paleontologists would prefer to describe the fossil record as "biased" rather than as "inadequate." They would point out that the process of fossilization is inevitably biased in favor of the preservation of hard-bodied rather than soft-bodied organisms, and in favor of those animals that die near large, shallow bodies of water rather than at higher elevations, and so on. When these biases are taken into account, paleontologists "... can make corrections for them in order to arrive at a balanced view of the life of the past" (Stearn and Carroll, *Paleontology*, 12).

[24]This information on *Ichthyostega* and the fish-amphibian transition is from Edwin H. Colbert and Michael Morales, *Evolution of the Vertebrates: A History of the Backboned Animals Through Time*, 4th ed. (New York: John Wiley & Sons, 1991), 67–9; I. I. Schmalhausen, *The Origin of the Terrestrial Vertebrates*, trans. Leon Kelso (New York: Academic Press, 1968), 34 ff.; and Robert L. Carroll, *Vertebrate Paleontology and Evolution* (New York: W. H. Freeman, 1988), 158 ff.

[25]Per E. Ahlberg, Jennifer A. Clack, and Ervins Luksevics, "Rapid Braincase Evolution between Panderichthys and the Earliest Tetrapods," *Nature* 381 (2 May 1996): 61–3.

[26]Carroll, "Revealing the Patterns of Macroevolution," 20.

[27]Carroll, *Vertebrate Paleontology and Evolution*, 361.

[28]Ibid., 362.

[29]T. S. Kemp, *Mammal-Like Reptiles and the Origin of Mammals* (London: Academic Press, 1982), 1. Kemp's statement implies, of course, that the transitions between other major vertebrate classes are less well-documented and based on inferences from small numbers of fossil remains.

[30]Colbert and Morales, *Evolution of the Vertebrates*, 228.

[31]Kemp, *Mammal-Like Reptiles and the Origin of Mammals*, 1.

[32]The above description is from Colbert and Morales, *Evolution of the Vertebrates*, 123–5.

[33]Ibid., 241.

[34]Ibid.

[35]The hominid fossil evidence is reviewed and analyzed in works such as Michael H. Day, *Guide to Fossil Man*, 4th ed. (Chicago: University of Chicago Press, 1986); Richard G. Klein, *The Human Career: Human Biological and Cultural Origins* (Chicago: University of Chicago Press, 1989); Roger Lewin, *Human Evolution: An Illustrated Introduction*, 3d ed. (Boston: Blackwell Scientific Publications, 1993); Ian Tattersall, *The Fossil Trail* (New York: Oxford University Press, 1995); and John Reader, *Missing Links: The Hunt for Earliest Man* (New York: Penguin Books, 1988).

[36]Anatomically, modern humans are more similar to the great apes (the gorillas and chimpanzees) than to any other living forms. At the molecular level of DNA sequences, humans and chimpanzees share an approximately 98% degree of similarity.

[37]Don L. Eicher and A. Lee McAlester, *History of the Earth* (Englewood Cliffs, NJ: Prentice-Hall, 1980), 236. The beginning of the Cambrian is generally dated approximately 570 million years (Myr) before the present.

[38]T. Peter Crimes, "The Period of Evolutionary Failure and the Dawn of Evolutionary Success: the Record of Biotic Changes across the Precambrian-Cambrian Boundary," in Stephen K. Donovan, ed., *The Paleobiology of Trace Fossils* (New York: John Wiley & Sons, 1994), 105–33 at 125. Richard Forty, *Fossils: The Key to the Past* (London: Heinemann, 1982) has noted: "The acquisition of shells and skeletons is one of the great milestones in the history of the biosphere, and the difficulty of finding a single neat explanation only adds to the fascination" (p. 148).

[39]E. N. K. Clarkson, *Invertebrate Paleontology and Evolution*, 2d ed. (London: Allen & Unwin, 1986), 48.

[40]Ibid., 51–2.

[41]Ibid., 52.

[42]H. B. Whittington, *Trilobites* (Woodbridge, UK: Boydell Press, 1992), 84–5.

[43]Clarkson, *Invertebrate Paleontology and Evolution*, 331.

[44]See Riccardo Levi-Setti, *Trilobites: A Photographic Atlas* (Chicago: University of Chicago Press, 1975), 23 ff.; Richard S. Boardman, ed., *Fossil Invertebrates* (London: Blackwell Scientific Publications, 1987), 227 ff.; and Whittington, *Trilobites* and Clarkson, *Invertebrate Paleontology and Evolution* above. According to Levi-Setti, the recently discovered properties of the trilobite eye lenses "represent an all-time feat of function optimization" (p. 23); the trilobites had

apparently in some remarkable fashion "discovered" and applied sophisticated principles of optics scientifically described by Descartes and Huygens in the seventeenth century so as to be able to correct for spherical aberration of light and form sharp images (p. 38).

[45]These and subsequent experiments are described in Stanley L. Miller and Leslie Orgel, *The Origins of Life on the Earth* (Englewood Cliffs, NJ: Prentice Hall, 1974), 83–102. Influential in origins of life research were the earlier speculations of Russian scientist A. I. Oparin, *The Origin of Life on the Earth*, 3d ed., trans. Ann Synge (Edinburgh: Oliver and Boyd, 1957). Oparin, operating from the philosophical standpoint of Marxist-Leninist "dialectical materialism," attributed self-organizing properties to matter: "Matter never remains at rest, it is constantly moving and developing ... [it] changes from one form of motion to another ... each more complicated and harmonious than the last. Life thus appears as a particularly very complicated form of the motion of matter, arising as a new property at a definite stage in the development of matter" (p. xii). While not necessarily sharing Oparin's dialectical materialism, other workers in this area, recognizing the great improbability of the chance origins of life, have similarly attributed powers of "self-organization" to inanimate matter.

[46]A very helpful overview and analysis of origins of life research is provided by Freeman Dyson, *Origins of Life* (Cambridge: Cambridge University Press, 1985), esp. 1–34.

[47]Metabolic processes are those by which the living organism converts nutrients from its environment into useful forms of energy; "replication," governed by the RNA and DNA molecules, refers to the processes by which the cell duplicates itself and its substructures.

[48]Francis Crick, *Life Itself: Its Origin and Nature* (London: Macdonald & Co., 1981). Needless to say, Crick's suggestion has not been taken very seriously by the scientific community.

[49]On the work of Manfred Eigen, see Manfred Eigen, *Steps Toward Life: A Perspective on Evolution*, trans. Paul Woolley (Oxford: Oxford University Press, 1992), and Manfred Eigen, et al., "The Origin of Genetic Information," *Scientific American* 244:4 (April 1981): 78–94; for a good overview of Orgel's work and a review of research in the field, see Leslie E. Orgel, "The Origin of Life on the Earth," *Scientific American* 271:4 (October 1994): 53–61.

[50]A.G. Cairns-Smith, *Genetic Takeover and the Mineral Origins of Life* (Cambridge: Cambridge University Press, 1982); a simplified layperson's account of this theory is presented in A. G. Cairns-Smith, *Seven Clues to the Origin of Life* (Cambridge: Cambridge University Press, 1985). Cairns-Smith believes that among the intractable problems faced by the more popular "primeval soup" model are: contamination of early prebiotic molecules by other chemical substances; the difficulty of achieving sufficiently strong concentrations of the essential molecules in the primordial ocean; and the problem of hydrolysis: left to themselves, complex molecules in a watery solution would break down into the simpler constituent amino acids (*Genetic Takeover*, 45–59).

[51]James P. Ferris, Aubrey R. Hill, Jr., Rihe Liu, and Leslie Orgel, "Synthesis of Long Prebiotic Oligomers on Mineral Surfaces," *Nature* 381 (2 May 1996): 59–61.

[52]Orgel, "The Origin of Life on the Earth," 61.

[53]For example, Henry Morris and Gary Parker, representing the "creation science" point of view (young earth, six-day creation, "Flood geology") state: "Evolution purports to explain the origin of things by natural processes, creation by preternatural process; and it is semantic confusion to try to equate the two" (Morris and Parker, *What Is Creation Science?* [El Cajon, CA: Master Books, 1987], 300). This would seem to be an example of the logical fallacy known as the fallacy of the excluded middle: "X must be explained in terms [and only in terms] of either A or B." Rather, it may be the case that X can be explained by C or D, or by some combination of A, B, C, D, and so forth. In the case of origins, it needs to be recognized that God is free to create through either natural or supernatural means, or through a combination of both.

[54]Rather than a two-fold distinction between "natural" and "supernatural" means, it is more biblically accurate to recognize a three-fold distinction among God's works of ordinary providence, special providence, and miracle. In ordinary providence, God works immanently through the regular laws of nature (e.g., causing the grass to grow through the processes of photosynthesis [Ps. 104:14]; creating animals through the normal processes of gestation [Ps. 104:24, 30]); in extraordinary providence, God redirects the forces and laws of nature (e.g., causing a wind to blow quail from the sea to feed the Israelites during the wilderness wanderings [Num. 11:31]); in miracles God transcends the laws of nature for a redemptive purpose (e.g., the floating axhead, [I Kings 6:6]; the feeding of the 5000; and the bodily resurrection of Jesus).

[55]In the perspective being argued here, "theistic evolution" is understood as a subcategory within the larger framework of "progressive creation." Biblical texts such as Gen. 1:20, 21, where God is said to create mediately by addressing the waters and the earth, can be seen as consistent with creation through natural processes. Biblical texts such as Gen. 1:21, 24 ("kinds") and I Cor. 15:39 ("all flesh is not the same": birds, animals, fish) can be seen as statements concerning the results of God's creative work—the major groups of animals are distinct and not interfertile—rather than excluding descent from a common ancestor with modification as a possible process of origination.

[56]Some proponents of theistic evolution as the more inclusive category seem to be reticent to recognize special divine interventions in the natural order. Howard J. Van Till, for example, believes that the creation's "functional integrity" and the natural order's "God-given creaturely capacities" are "... sufficiently robust so as not to require additional acts of special creation ... to actualize the full array ... of life forms that have ever existed" (Van Till, "Basil, Augustine, and the Doctrine of Creation's Functional Integrity," *Science and Christian Belief* 8:1 [1996]: 21–38 at 29). See also Van Till, *The Fourth Day: What the Bible and the Heavens are Telling Us about the Creation* (Grand Rapids: Eerdmans, 1986), esp. chaps. 1–5. The terminology of "progressive creation" argued in the present article seems to be a more adequate way of explicitly affirming the theological categories of miracle (e.g., the resurrection) and special providence (e.g., answers to petitionary prayer) that are essential for biblical faith.

Do Phyletic Lineages Evolve from the Bottom Up or Develop from the Top Down?

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There are two logical possibilities of how species and large groupings of animals, called phyla, changed over geologic time. The first is from the bottom up, i.e., from varieties, species, genera, families, up to higher taxa. The second is from the top down, from higher taxa—phyla, classes, orders—down to species. This article reviews and evaluates current data and arguments purporting to confirm the bottom-up framework. The top-down concept is examined considering the data on phyletic trends following the Cambrian explosion as detected in the fossil record. Paleontological and biological data substantiate the top-down direction of change. A new theoretical framework, based on principles of development, is proposed to account for the top-down trends.

This paper will evaluate two fundamental hypotheses regarding how phyletic lineages changed over geologic time. A phyletic lineage is a genetically continuous animal group existing over long periods of time. The first hypothesis may be called the "bottom-up" hypothesis. Proposed by Darwin, it claims that lineages start with varieties and species which become modified "upward" into higher taxonomic levels.[1] The second hypothesis is designated the "top-down" hypothesis in which phyletic lineages, starting at the top of the taxonomic hierarchy, differentiate "downward" to the lower taxonomic levels.[2] The first represents the Darwinian paradigm; the second embodies the hierarchical developmental perspective.

Both hypotheses cannot be true. Since sufficient physical data are now available, a definitive judgment can be made about which one most closely matches the biological and paleontological data. The confirmation of one will likely disconfirm the other.

Hierarchies in Organic Life

The terms "top-down" and "bottom-up" draw their meaning from the natural hierarchies in organic life. Hierarchical organization is a fundamental characteristic of organic life,[3] although such organization is not always easy to detect because the data disclosing it tend to be "messy" and are almost swamped by "noise." Arthur has identified three natural hierarchies—morphological, genealogical, and genetic.[4] This article will use the first two. A morphological hierarchy is a linear or nearly linear ranking of animals and plants in terms of form and structure, with organisms at each level possessing morphological characteristics of those above it, but none of the features of those below. The first putative chordates, for instance, did not have any appendages—fins were added later, later legs, still later fur. A genealogical hierarchy is a regular chronological descent of a group of organisms from a progenitor or ancestor down to the last members of the group, usually diversifying along the way.

Using both morphological and genealogical hierarchies in a mixed fashion, Linnaeus constructed a system for classifying plants and animals which is known today as the Linnaean hierarchy. Although greatly modified through the years, it is the internationally accepted system of taxonomic nomenclature—with the taxonomic category phylum at the top of the animal kingdom, followed by class, then order, family, genus, and species. (See Appendix A, p. 269.) The Linnaean hierarchy will be used in this article with the understanding that it is based on the natural morphological and genealogical hierarchies.

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In the Linnaean system, the topmost organisms in the natural or morphological hierarchy of a group of animals are accorded the rank of phylum.[5] The most distinguishing feature of the phylum is the body plan or basic architecture. Exhibited in Cambrian animals, which appeared around 525 million years ago, the body plan is passed on to all their progeny and is the identifying characteristic of the phylum or lineage. Worms, insects, and mammals, for instance, have basic body plans characteristic of their phylum. The top-down direction thus starts at the phylum level. At each lower level in the taxonomy, more specific morphological features are added to the lineage. At the bottom of the natural hierarchy lie the most specific organisms which, in the Linnaean system, are called species or varieties. The bottom-up direction works in the opposite direction. According to Darwin, it starts with species, in the Linnaean sense, and works upward to higher taxa, orders, classes, and phyla.

The Bottom-Up Direction—The Darwinian Perspective

Darwin's Diagram

Darwin's diagram marks the birthplace of the "bottom-up" concept of evolution, also called the "specific-to-general" direction of phyletic change.[6] It provides the clearest picture of the purported evolutionary direction of lineal modification, with the branching pattern of speciation as depicted in Fig. 1.

Darwin explained his diagram as follows:

> Thus the diagram illustrates the steps by which small differences distinguishing varieties are increased into larger differences distinguishing species. By continuing the process for a greater number of generations ... we get eight species marked by the letters between a^{14} and m^{14} all descended from (A). *Thus, as I believe, species are multiplied and genera are formed* (My emphasis).[7]

Darwin next extended the process of modification of species to the taxonomic levels of families and orders, by means of natural selection. He states:

> I see no reason to limit the process of modification, as now explained, to the formation of genera alone ... These two groups of *genera* will thus form two distinct *families*, or *orders*, according to the amount of divergent modification supposed to be represented in the diagram (My emphasis).[8]

These clear, unambiguous statements constitute Darwin's hypothesis of how major evolutionary change should occur. What is predicted by his hypothesis is spelled out in the following six elements:

1. Evolution starts at the bottom of the natural hierarchy, with varieties and Linnaean species at the very lowest taxonomic level ("small differences distinguishing varieties").[9]
2. Numerous species will be formed ("species are multiplied").
3. The process is a long one (implied by many generations of species).
4. Species will diverge from each other ("divergent modification").
5. New higher taxonomic innovations will result ("genera will be formed ... two groups of genera will thus form two distinct families or orders").
6. The hypothetical *process* proposed by Darwin is speciation (the formation of species); the *mechanism* is natural selection (random genetic variation, resulting in animals which are sorted out by the environment) so that the most adaptive, reproductively successful individuals and populations survive.

It needs to be emphasized that it is the *direction* of phyletic change that is being evaluated in this paper. Secondarily, Darwin's process of speciation and the mechanism of natural selection are also

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evaluated. Natural selection is the linchpin of evolutionary theory, the major Darwinian mechanism of change in the organic world.

While Darwin's interpretation of his diagram began as a hypothesis, today it is treated by many as a fact and has become an essential element in the established Darwinian paradigm. Below are some statements illustrating the widespread acceptance of Darwin's doctrine as a statement of fact.

After a lengthy and convoluted discussion of speciation, Simpson, a major author of the Modern Synthesis of evolution, concluded:

> Phylogenetic splitting of lineages, including those from which *higher* categories *up* to the *highest* later develop, thus occurs by *speciation at their bases* (My emphasis).[10]

Mayr, another architect of the Modern Synthesis and a major evolutionary author, stated:

> The origin of new species ... is the most important single event in evolution.
>
> The species are the real units of evolution ... And speciation, the production of new gene complexes capable of ecological shifts, is the method by which evolution advances. Without speciation there would be no diversification of the organic world, no adaptive radiation, and very little evolutionary progress. The species, then, is the keystone of evolution.[11]

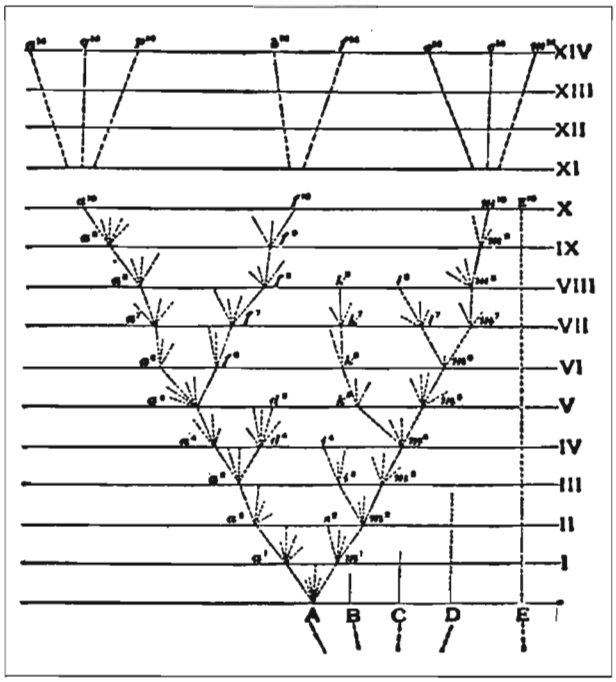

Fig. 1. Darwin's diagram. The diagram illustrates how eight species on the top line, from a^{14} (far left) to m^{14} (far right), hypothetically descended from species A, on the bottom line. Each row, I to XIV, represents 1,000 generations. The top species are 14,000 generations removed from species A. (Taken from C. Darwin, *Origin of Species* [London: Dent, 6th ed., 1872. Reprinted in Everyman's Library, 1958]), 120–1.

The Darwinian notion of the branching, bottom-up direction of change, leading to higher animal groups, is reaffirmed by Eldredge:

> In his only diagram in *On the Origin of Species*, Darwin depicted the results of his process of "descent with modification" as a historical, branching pattern. New branches arise from old ... A hierarchical array of evolutionary novelties—*homologies*—automatically results from the simple process of branching and descent with modification. This pattern, in fact, is the most important prediction about the way the biological world is structured that arises from the scientific hypothesis of "evolution."[12]

This statement needs clarification. The phrase, "hierarchical array of evolutionary novelties" means *new, higher taxa*; and "automatically results from the simple process of branching and descent with modification" means *forming species by means of natural selection*. Eldredge claims that Darwin's diagram is his most important, if not indispensable, prediction. The centrality of the bottom-up hypothesis is clearly established by Darwin and his followers.

Some non-Darwinian authors have also accepted the bottom-up track of evolution. Martin asserted:

> Evolution begins with the production of new species, which gradually differ more and more from each other until new genera, families, classes, etc., have evolved.[13]

Edwards stated:

> A population may undergo continuous evolutionary change that can result in the origin of new varieties, species, genera, or indeed new populations at any taxonomic level.[14]

In summary, Darwin's hypothesis that evolution works from the bottom up is clearly formulated and has become more than a hypothesis. It could be called the central dogma of Darwinism. It is held almost universally in the scientific community and among large segments of the general population.

Do Data from Biological Studies Confirm the Bottom-Up Direction?

In a recent article in *Natural History*, Gould reviewed several studies that purport to reveal how evolution works.[15] Briefly, the first study by Resnick showed that guppies in Trinidad which inhabited high-predation pools bred faster and more copi-

ously, matured faster, and were smaller than guppies living in low-predation pools.[16] The explanation is that the threat of predation favors rapid sexual maturation. Thus guppies reproduce in large numbers before being eaten. When the experimenter transferred guppies from high-predation downstream pools into low-predation upstream waters, they quickly (4–11 years) adopted a more relaxed lifestyle because the threat of predation was gone. This new lifestyle resulted in delayed sexual maturity, growth to a larger size, and a longer life.

A second study by Losos showed how lizards, living on a Bahamian island covered with large trees and thick branches which served as perching places, had evolved long legs. When these lizards were transferred to another island with bushy, narrow, twiggy growth, in less than twenty years, they evolved slightly shorter legs which were more adapted to these precarious perches.[17]

Other short-term evolution studies have been reported, such as Kettlewell's famous studies of industrial melanism in peppered moths;[18] Schluter's studies of a population of sickleback fish which began to change shape and feeding habits when a new competitor forced the fish toward a different ecological niche;[19] Endler's observations of guppies in the wild, which when living in streams with predatory fish, blended with the sand on the stream bed for camouflage, whereas in streams lacking predators guppies displayed more visible colors, with spots bigger than sand grains;[20] and Vrijenhoek's finding that sexually and asexually reproducing lines of topminnows vary in their resistance to flatworms which burrow into their bodies and give them black spot disease.[21]

Weiner extrapolated these various studies of short-term evolution into a model of how the history of life worked, i.e., how microevolution operated from the bottom up to produce major innovations in vertebrates, fish, amphibians, insects, and human beings. Referring to these short-term evolution studies, he wrote: "The history of these radiations *is the history of life*."[22] His interpretation is probably widely accepted in the scientific community.

Do these studies provide a model for bottom-up evolution? Gould thinks not. He concluded that *in all of these studies, microevolution occurs at rates far too rapid to serve as models for bottom-up evolution.* He wrote:

> These shortest-term studies are elegant and important, but they cannot represent the general mode for building patterns of life history ... Evolutionary rates of the moment as measured by guppies and lizards, are vastly too rapid to represent the general modes of change that build life's history through geological ages ... These measured changes over years and decades are too fast by several orders of magnitude to build the history of life by simple cumulation.[23]

Resnick stated:

> The estimated rates [for guppies] are ... four to seven orders of magnitude greater than those observed in the fossil record "(that is, ten thousand to ten million times faster!)."[24]

Even more important is the fact that these studies show that the changes are minor, oscillating, and transient. As Gould concluded:

> Most cases such as the Trinidadian guppies and Bahamian lizards represent the *transient* and *momentary blips* and *fillips* that "flesh out" the rich history of lineages in stasis (My emphasis).[25]

Niles Eldredge, curator of the American Museum of Natural History, challenged the misinterpretation and unwarranted extrapolation of microevolution into macroevolution as follows:

> It is dawning on us all, geneticists and paleontologists alike, that the constant genetic churning within individuals, and even within populations, does not mean that the constantly running motor of genetic change will necessarily alter the way a species looks even through long segments of geologic time. Rather than assuming that the small-scale changes necessarily add up, inevitably, to large-scale change as the geologic ages roll, many of us now see that evolution is a hierarchical process—and that what happens at one level need not specify what goes on at the next higher level.[26]

Darwin's Finches

Thirteen species of Darwin's finches live on the Galápagos Islands.[27] They arrived earlier than other birds and encountered an abundance of unoccupied ecological niches. The finches thus would have undergone extensive adaptive radiation, evolving a variety of species and probable genera, which could exploit opportunities for living such as are exploited by other kinds of birds in balanced continental fauna.[28] The size and conformation of the beak are adaptively adjusted to the kind of food on which a given bird depends. Fig. 2 illustrates the diversity of feeding habits of these species of finches, and also their variety of beak shapes.

No higher taxa, however, have been formed, only additional species and genera. To extrapolate these minor microevolutionary modifications at the spe-

cies level into major innovations at the level of higher taxa is unjustified.

In conclusion, Darwin's hypothesis finds slight empirical support in his finches' study at the lower taxonomic levels (species, genera), but none at the higher taxonomic levels (orders, classes, phylum). His hypothesis finds no support in short-term evolution studies. First, changes depicted in these studies are minor, transient, and occur far too rapidly to be considered the first step in the bottom-up direction. Second, no higher taxa at the level of orders and above have emerged in these studies.[29] They fail to substantiate the indispensable element in Darwin's hypothesis—*the production of higher taxa by means of speciation and natural selection*. Williams concluded: "Speciation in the usual sense (of Mayr) has no special significance for macroevolution."[30] The bottom line of this review is that Darwin's hypothesis fails to be supported at the higher taxonomic levels.

The Top-Down View

The Cambrian Explosion

The Cambrian explosion, called by some "The Big Bang of Animal Evolution," provides an excellent introduction to the discussion of the top-down hypothesis.[31] Life took an enormous leap forward in this explosion, starting 530 million years ago and

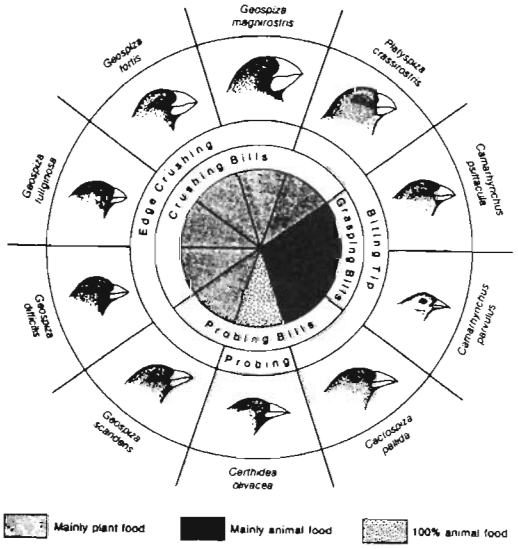

Fig. 2. Darwin's finches. Ten species of *Geospizinae* from Indefagitable Island in the Galápagos. Different species feed on different foods and have evolved beaks adapted to their feeding habit. (Taken from Th. Dobzhansky, F. J. Ayala, L. Stebbins, and J. W. Valentine, *Evolution* [San Francisco: Freeman, 1977]), 187.

ending five million years later[32]—a mere eye-blink in the totality of the three billion-plus years that life existed on earth. An amazing number of fifty Cambrian animals sprang upon Earth's stage in that small window of time. Moreover, each animal was unique and distinct from all others. These founding animals are accorded the top-level rank, phyla and classes, within the animal kingdom in the Linnaean system. The Cambrian animals were the ancient founding parents of all but one (Bryozoa) of the major groupings of animals, 37 of which have survived to the present time.[33] This then is where the top-down direction of change had its origin.

Each of the fifty animals possessed its own unique structural architecture or body plan, which became the identifying characteristic of the phylum they founded. They bequeathed this body plan on all their progeny. Even today it shows up in the embryonic stage of every one of their offspring and is the distinguishing mark of each phylum.[34]

In sum, four characteristics mark the Cambrian explosion from all other events in the history of life: (1) its amazing *speed* (five million years), (2) its incredible *breadth* (fifty disparate, unique animals), (3) its *finality* (only one additional phylum formed after this time), and (4) its *significance* (it is the *point of origin* of virtually all animal phyla).

The Neoproterozoic

The period prior to the Cambrian explosion is called the Precambrian or Neoproterozoic. For a long time, we knew practically nothing about it. Recent discoveries have produced four extraordinary findings: (1) exquisitely preserved, tiny fossil embryos were found in China;[35] (2) microscopic sponges, among the earliest of living multicellular animals, also were found in China;[36] (3) the latest molecular clock study indicates that a key branch-point in the tree of life occurred about 670 million years ago,[37] much later than a previous study had concluded;[38] and (4) groups of animals of possible affinity to the Cambrian animals were found in the Neoproterozoic.[39] Space limitations prevent a discussion of these remarkable findings.

The discoveries of these Neoproterozoic precursors do not reduce the importance of the Cambrian explosion.[40] Gould called the Cambrian explosion a "rapid spurt of anatomical innovation within the animal kingdom,"[41] perhaps using various "developmental patterns"—as Vermeij called them—found in Neoproterozoic life.[42] Arthur concluded that "the explosion around the base of the Cambrian produced the body plans on which all of today's

phyla are based ... Even if it turns out that the main lineage divergences occurred much earlier."[43] As Vermeij claimed: "The new work in no way diminishes the significance of the Vendian-Cambrian revolution."[44] Moreover, to my knowledge, no one has provided an explicit explanation of how Darwin's hypothesis could account for the new Neoproterozoic findings.

More important, the existence of embryos, tiny sponges, and other animals in the Neoproterozoic tell us that the process of individual development was already well-established and fully operational.[45] This evidence strongly suggests that development did not evolve by Darwinian processes and mechanisms, as some developmental evolutionists maintain.[46] Rather, it was already a robust, independent process at the start-up of complex, multicellular life and was at least one of the critical causal factors in the origin of that life.[47]

Top Down—The Developmental Perspective

The top-down direction of change refers to the course of events following the Cambrian explosion, in which thirty-seven of the original fifty phyletic lineages advanced on their long geological journey, from the early, top-hierarchical levels to the later, lower ones. Each phylum was built in the shape of a step-pyramid in Egypt. The capstone of each phylum consisted of the Cambrian stem animal whose body plan identified the phylum or lineage it engendered. Organisms at each lower level possessed morphological characteristics of those above it, but none of the features of those below. Each step down added more morphological features of class, order, etc.; larger numbers; and more diversity in the lineage. The process of differentiation proceeded thus until the bottom of the hierarchy was reached, represented by numerous Linnaean species and varieties.

A study of the origin and early differentiation of phyletic lineages of a large data base of skeletonized, invertebrate, marine fossils which existed during the 250 million year era following the Cambrian explosion, called the Paleozoic, was conducted by Erwin, Valentine, and Sepkowski.[48] They found that all fossils could be classified into eleven distinct phyla using the Linnaean classification system. Seven of the eleven phyla appeared within the first twenty-five million years of the Paleozoic era, indicating their origin at or near the Cambrian explosion.

The eleven phyla could next be subdivided into 62 classes, which is the next lower category in the Linnaean system. Class-level animals (not including some stragglers) emerged over a period of 230 million years, with the midpoint at about eighty million years after the start of the Paleozoic, and fifty-five million years later than the midpoint of the distribution of phyla.

The top-down direction of change refers to the course of events following the Cambrian explosion, in which thirty-seven of the original fifty phyletic lineages advanced on their long geological journey, from the early, top-hierarchical levels to the later, lower ones.

The classes, in turn, could be subdivided into 307 orders (the next lower, more specific taxonomic category) with many more members than the higher categories. The midpoint of the distribution was at 190 million years after the start of the Paleozoic, which is 110 million years later than the midpoint of classes, and 165 million years after the midpoint of the phyla. The authors concluded:

> Most higher taxa were built from *the top down*, rather than from the bottom up. The fossil record suggests that the major pulse of diversification of *phyla* occurs before that of *classes*, *classes* before that of *orders*, *orders* before that of *families* ... *the higher taxa do not seem to have diverged through an accumulation of lower taxa* (My emphasis).[49]

Each hierarchical level, therefore, differentiated out of the one preceding it: Classes are derived from phyla; and orders emerge from classes. Finally, the number of lower-level taxa increased in each lower distribution. Each phylum differentiated, on the average, into 5.6 classes; each class, on the average, into 4.9 orders. This threefold process has the shape of the step-pyramid; (1) top-down differentiation, (2) emergence of lower out of higher groups, and (3) spreading out and diversification at each lower level. These data are what the top-down, developmental framework would predict, but not what Darwin's hypothesis anticipated.

The data on marine invertebrates presented above were reworked and extended down to the species level by Signor.[50] His study shows that the major pulse of species formation came *after* the higher taxonomic levels were all in place. Species diversity thus

lags behind rather than leads the way. According to Signor, species richness increased by a factor of five in the Cenozoic (the most recent geological era which includes the present). It is estimated that 605,000 fossilized marine invertebrate species existed during the Cenozoic (65 million years in length) versus 44,000 species during the Cambrian period about 530 million years ago (an almost equal period of 60 million years), or almost 14 times more species in the Cenozoic. Signor wrote that there have been as many species in the Cenozoic as there were in all the previous 500 million years. As Valentine said:

> A striking aspect of the Lower Cambrian faunas is that although diversity of higher taxa was great, species diversity was low. This appears not to be an artifact of the record ... Reconstructions of diversity patterns provide estimates of standing species diversities of only a few thousand during earlier Cambrian stages.[51]

Species multiplied *after*, not before, all the higher taxa were in place. This is a significant confirmation of the top-down hypothesis and a cogent challenge to Darwin's hypothesis. This trend of delayed increase in species abundance helps explain why short-term evolution studies produce only species but no higher taxa. Higher taxa are already in place, produced by top-down phyletic-developmental processes. All that remains for natural selection to produce is more species diversity.

Signor's study shows that the major pulse of species formation came* after *the higher taxonomic levels were all in place ... This is a significant confirmation of the top-down hypothesis and a cogent challenge to Darwin's hypothesis.

Other research on the fossil record supports the top-down, general-to-specific direction of change. These studies are important because they show that the top-down pattern of phyletic development and growth occurred (1) in other animal groups besides the well-skeletonized marine invertebrates, (2) at lower taxonomic levels of families, genera, and species, as well as in higher ones of phyla, classes, and orders; and (3) in later geological periods as well in the Cambrian.

Among trilobites, an extinct group of arthropods, the top-down pattern of change occurred at the taxonomic levels of families and genera. Valentine reported the top-down direction as follows: *Families* of trilobites peaked *early* in the Cambrian and *genera* crested *late* in the Cambrian. The proportion of families to genera is highest in the early Cambrian. Later the proportion reverses itself and genera outnumber families; there are roughly 7.5 times as many genera as families. He concluded: "Little or no real evolutionary advance was taking place."[52]

The top-down pattern of change is also found in amphibia, reptiles, and mammals at the taxonomic levels of orders, families, and genera. Over the latter half of the Phanerozoic, Simpson found that orders peaked before families, and families before genera among amphibians and mammals. In discussing Simpson's results, Padian and Clemens stated:

> *Classes* appeared in the fossil record some 25 to 30 million years before they achieved maximum *ordinal* diversity; after a similar interval, the orders achieved maximum *generic* diversity (My emphasis).[53]

Not only did amphibians and mammals develop from the top down, they also proliferated as they differentiated. There are roughly five times as many families as orders, and about ten times as many genera as families. The sequence of appearance is less clear among reptiles.

Simpson also suggested the general-to-specific direction of phyletic change. Regarding the general order of appearance of different taxonomic levels, he observed:

> If time frequency curves are plotted for the same group in terms of different taxonomic levels, the peaks for higher categories usually appear earlier than those for lower categories ... Even when using the coarse scale of periods, peaks for different categories are in the same period, those of higher categories are earlier in the period as the data from mammals show.[54]

Birds developed very rapidly and also followed the general-to-specific direction of differentiation. Feduccia observed:

> This explosive evolution paralleled that of mammals, producing all the modern lineages of birds within about 10 million years, yielding modern *orders* by the Paleocene and Eocene, modern *families* by the late Eocene or early Oligocene, and modern *genera* by the Miocene (My emphasis).[55]

The general-to-specific pattern of change is thus replicated among complex vertebrates at lower taxonomic levels throughout much of the Phanerozoic as well as among invertebrates at higher taxonomic

levels. Roger Lewin, a well-known science writer, wrote:

> Several possible patterns exist for the establishment of higher taxa, the two most obvious of which are the bottom-up and the top-down approaches. In the first, evolutionary novelties emerge, bit by bit ... The Cambridge explosion appears to conform to the second pattern, the top-down effect.[56]

In 1952, Goldschmidt summarized the top-down view when he described the direction of change in the fossil record after the Cambrian explosion as follows:

> A phylum consists of a number of classes all of which are basically recognizable as belonging to the phylum but, in addition, are different from each other. The same principle is repeated at each taxonomic level. All genera of a family have in common the traits which characterize the family ... So it goes down to the level of species. Can this mean anything but that the type of phylum was evolved first and later separated into the types of the classes, then into orders, and so on down the line?[57]

In summary, phyletic groups, originating in the Cambrian animals, developed in geologic time in the top-down direction. Phyla differentiated downward to each lower level, and increased in number and diversity of representative organisms at each level. Higher taxonomic levels were in place before species multiplied in large numbers. Major innovations preceded minor variations, contrary to Darwinian predictions. Evidence from the fossil record supports the conclusion that the pervasive direction of change and modification works from the top-most, general levels to lower, more specific ones. Based on empirical studies, the conclusion supports the top-down hypothesis, and moreover, contradicts the direction of change predicted by Darwin's diagram.

Objections to the Top-Down Interpretation

Simpson, a prominent evolutionary author, has not hesitated to mount vigorous attacks on the top-down interpretation of paleontological data. First, he dismissed the straight-forward interpretation that peaks of higher taxa appeared in the fossil record before peaks of lower ones as, "off-hand ... a manner of speaking, a broad and figurative view of the net result rather than a description of the process, even an artifact of classification."[58] To imply, however, that the differentiation of marine invertebrates, described by Erwin, et al., is an "artifact of classification," rings hollow when the authors, who are committed evolutionists, consciously used taxonomic classifications, stating:

> The fossil record suggests that the major pulse of diversification of *phyla* occurs *before* that of *classes*, classes *before* that of *orders*, orders *before* that of *families*.[59]

Second, Simpson asserted that since every higher taxonomic category is also a species, then by definition, higher taxa originated as species. Referring to adaptive radiation of the family of finches (Geospizidae) on the Galápagos, he stated: "The family did not arise as such, but as a species."[60] This, however, is not the way Darwin used the concept of species, nor is it what he meant. Darwin postulated a long-branching series of numerous Linnaean species—not just a single nominal species—changing over time, finally becoming higher taxa.

Mayr rejected the biological reality of higher taxonomic categories, stating that they are largely arbitrary and artifactual.

Third, Mayr rejected the biological reality of higher taxonomic categories, stating that they are largely arbitrary and artifactual. He attacked the position of Goldschmidt presented above by stating:

> With this interpretation Goldschmidt has fallen into the error of considering these categories something natural rather than (particularly in the crucial area of branching) a man-made artifact.[61]

Of course! Categories of thought, even language itself, are human artifacts. Behind the Linnaean system, however, lie the natural morphological and genealogical hierarchies which they represent, albeit imperfectly. Mayr's criticism should also apply equally to Darwin, who freely used the taxonomic categories of species, genera, families, and even orders in formulating his bottom-up hypothesis.

Parallel Between Phylogenetic and Developmental Hierarchies

Phyletic lineages are hierarchically organized; animals at the highest levels of the morphological hierarchies of phyletic lineages appeared first in the Cambrian explosion, and lower levels differentiated out of higher ones over geologic time. Phyletic hierarchies are evident in the fossil record and are reflected in the Linnaean classification system.

Are morphological hierarchies also evident in the embryonic development of individual animals (ontogeny)? If so, do they correspond in any way to the hierarchies in phylogeny? Answers to these two questions are difficult to determine from the Neoproterozoic, where most of the phyla probably had their roots. Determining the origin of phyla before the Cambrian explosion and their genealogical relationships to each other is problematic because of the difficulties and disagreements in interpreting microbiological findings and meager fossil data.[62] Despite these difficulties, Arthur saw a parallel between early phylogeny and early embryology. He states:

> Both ontogeny and phyologeny are, in certain respects, hierarchical processes ... There is a period of intense morphogenic creativity [in individual embryology, DH] associated with the early branching of the cell lineage hierarchy extending from cleavage and gastrulation up to early organogenesis. This is a broad parallel with early body-plan creativity associated with early genealogical branching of phyletic lineages ... The taxonomically broadest characters are also the embryologically earliest.[63]

Valentine and Erwin stated the same thing more simply: "There is a fairly clear general parallel between developmental patterns and the patterns of distinctiveness of adult body plans of [Cambrian] animals."[64] A perfect parallel, however, is not to be expected since many random events affect phyletic patterns over geologic time.

The characteristics of the fossil embryos are similar to the characteristics of modern embryos. This suggests that development was at least a major causal factor in the origin and early development of phyla.

The relationship between phyeltic and individual embryonic development was proposed long before Darwin's day. In 1844 Chambers stated:

> Here we have very clear demonstrations of a parity, or rather a identity, of laws presiding over the development of animal tribes [phyletic groups, DH] on the face of the earth, and that of the individual in embryo.[65]

We have noted above that developmental processes were already well established in the Neoproterozoic as evidenced by the earliest fossil embryos found in China. The characteristics of the fossil embryos are similar to the characteristics of modern embryos. This suggests that development was at least a major causal factor in the origin and early development of phyla.

In terms of the body plan, the parallel between individual embryological development and phyletic development is spelled out in greater detail below:

1. Primacy of the body plan. The body plans of individual animals are among the very first anatomical structures to appear in the embryo. The body plans of Cambrian animals were established early in the history of phyletic lineages. They were among the very first phyletic structures to appear in the Cambrian explosion.

2. Rapid origin of body plans. In individual human development, the basic body plan, including the major organ systems, develop rapidly within the first couple of months after fertilization of the egg. The Cambrian animals with their body plans emerged within a period of five to ten million years, which amounts to something less than one percent of the 525 million years or so that have elapsed since.

3. Stability of body plans. In individual animals, the basic body plans are extremely stable; mutations are lethal or severely detrimental during this early embryonic stage. Minor variations generally appear in later stages of development.[66] Body plans of Cambrian stem animals are also extremely stable.[67] They have remained essentially unchanged for more than 500 million years, and in the main phyla, across many thousands of species.[68] Mutations modify transient characters, e.g., coloration, shape of beaks, but not the basic body plans.

4. Top-down direction of change. The general direction of embryonic development is from the earliest, most general, most stable features to later, minor, and specific ones. Phyla also developed hierarchically, from the top down, as discussed in earlier sections of this paper.

In summary, the primacy of the body plans, their early rise, their rapid formation, and their stability suggest that the early stages of phyletic development result from developmental processes, as in individual development, and are not critically influenced by Darwinian mechanisms. As phyletic development runs its course over geologic time, however, developmental processes gradually give way to natural selection and speciation (microevolution) which add minor adaptive variations to the already established lineage. The relationship of phyletic de-

velopment to individual development warrants further research.

Philosophical and Theological Implications

Briefly, what are the philosophical and theological implications of this paper?[69] Darwinian evolution, as Denton correctly observed, is:

> the centrepiece, the crowning achievement, of the naturalistic view of the world, the final triumph of the secular thesis.[70]

The naturalistic worldview is based on the centrality of Darwinian natural selection.[71] This paper challenges the scientific validity of the central Darwinian mechanism of evolution, and, therefore, the centerpiece itself and the naturalistic worldview it supports.

Summary and Conclusions

Darwin's hypothesis, that higher taxa evolved from lower taxa by means of natural selection, finds limited support at the lowest taxonomic levels, but none at the higher levels. Natural selection as shown in microevolution does not appear to have been a major causal factor in the early geologic history of the great groups of animals. Microevolution as exemplified in short-term evolution studies produces only trivial, transient variability, and occurs too rapidly to serve as a model of macroevolution. It is unwarranted for Darwinian authors to extrapolate short-term evolution into macroevolution.

Evidence from paleontology, moreover, indicates that the pervasive pattern of change in the major animal groups is from the top down, not from the bottom up. The top-down hypothesis thus receives strong support from the fossil record. The top-down pattern of *individual development* parallels the patterns of *phyletic development*. This suggests that internal developmental processes, not Darwinian mechanisms, constitute the critical causal process accounting for the top-down direction of change in phyletic lineages. How this occurred, however, requires further study. ✯

Acknowledgment

Advice on this paper was received from John Wiester and Arthur Battson, for which I am grateful.

Appendix A

Linnaean Taxonomic Categories for Classifying Animals and Plants Illustrated by Human Lineage[1]

Linnaean Categories	Human Lineage
KINGDOM	Animalia
Subkingdom	Metazoa
PHYLUM	Chordata
Superclass	Gnathostomata
CLASS	Mammalia
Subclass	Theria
Infraclass	Eutheria
ORDER	Primates
Suborder	Anthropoidea
Superfamily	Hominoidea
FAMILY	**Hominidae**
Subfamily	Homininae
GENUS	Homo
SPECIES	sapiens
Subspecies	*sapiens*

[1]Taken from J. Z. Young, *The Life of Vertebrates*, 3d ed. (Oxford: Clarendon Press, 1981), 13.

References and Notes

[1]Higher taxa, in this paper, will refer to the taxonomic levels of phyla, classes, orders.

[2]Lower taxa will refer to taxonomic levels of species, genera, and families.

[3]Th. Dobzhansky, "Species and Their Origins" in Th. Dobzhansky, F. J. Ayala, L. Stebbins, and J. W. Valentine, *Evolution* (San Francisco: Freeman, 1977), 168–9; and W. Arthur, *The Origin of Animal Body Plans* (Cambridge: Cambridge University Press, 1997).

[4]W. Arthur, Ibid., 259–64.

[5]The term "phylum" is used in two ways that may lead to confusion. First, it refers to the topmost taxonomic cate-

gory in the Linnaean system; second, it refers to the entire lineage or genealogical grouping of animals.

[6]C. Darwin, *Origin of Species* (London: Dent, 6th ed. 1872. Reprinted in Everyman's Library, 1958), 121. This diagram is possibly the most published diagram in the history of evolutionary biology.

[7]Ibid., 112.

[8]Ibid., 115.

[9]Eldredge employs even "lower" levels, starting with germline, organism and demes, the former being composed of hierarchically nested chromosomes, genes, codons, and base pairs. N. Eldredge, *Macroevolutionary Dynamics* (New York: McGraw-Hill, 1989), 157.

[10]G. G. Simpson, *The Major Features of Evolution* (New York: Simon and Schuster, 1953), 383–4.

[11]E. Mayr, *Animal Species and Evolution* (Cambridge, MA: Harvard University Press, 1963), 11, 621.

[12]Eldredge, *Macroevolutionary Dynamics*, 1.

[13]E. A. Martin, *The Dictionary of Life Sciences* (New York: Pica, 1984), 131.

[14]P. Edwards, ed., *The Encyclopedia of Philosophy*, vol. 1 (1967, reprint, New York: Macmillan, 1972), 297–8.

[15]S. J. Gould, "The Paradox of the Visibly Irrelevant," *Natural History* 106 (12/97–1/98): 12–8, 60–6.

[16]D. N. Reznick, F. H. Shaw, F. H. Rodd, R. G. Shaw, "Evaluation of the Rate of Evolution in Natural Populations of Guppies (*Poecilia reticulata*)," *Science* 275 (March 28, 1997): 1934–7; and V. Morrell, "Predator-Free Guppies Take an Evolutionary Leap Forward," *Science* 275 (March 28, 1997): 1880 quoted in S. J. Gould, "The Paradox of the Visibly Irrelevant," 15–6.

[17]J. B. Losos cited in S. J. Gould, "The Paradox of the Visibly Irrelevant," 16–8. See also, V. Morell, "Catching Lizards in the Act of Adapting," *Science* 276 (May 2, 1997): 682–3.

[18]H. B. D. Kettlewell, "Selection Experiments on Industrial Melanism in *Lepidoptera*," *Heredity* 9 (1955): 341.

[19]D. Schluter, "Experimental Evidence that Competition Promotes Divergence in Adaptive Radiation," *Science* 266 (Nov. 4, 1994): 798–800; and J. Weiner, "Evolution Made Visible," *Science* 267 (Jan. 6, 1995): 30.

[20]J. Weiner, "Evolution Made Visible," 30–3. See also D. N. Reznick, et al., "Evaluation of the Rate of Evolution," 1934–7.

[21]J. Weiner, "Evolution Made Visible," 32.

[22]J. Weiner, *The Beak of the Finch* (New York: Random House, 1994), 208.

[23]S. J. Gould, "The Paradox of the Visibly Irrelevant," 62, 64.

[24]Quoted in V. Morrell, "Predator-Free-Guppies Take an Evolutionary Leap Forward," *Science* 275 (March 28, 1997): 1880.

[25]S. J. Gould, "The Paradox of the Visibly Irrelevant," 64.

[26]N. Eldredge, "What Drives Evolution?" *Earth* (December 1996): 37.

[27]P. Grant and B. Rosemary Grant, "Hybridization of Bird Species," *Science* 256 (April 10, 1992): 193–7; J. Weiner, *The Beak of the Finch*, 17; and see also Th. Dobzhansky, "Species and Their Origins," 186–7.

[28]P. Grant and B. Rosemary Grant, "Hybridization of Bird Species," *Science* 256 (April 10, 1992): 193–7. Peter and Rosemary Grant reproduced and extended Darwin's original studies of finches, and reported that changes in the type of available seeds produce changes in the beak size and shape of the finches within a single year.

[29]S. F. Gilbert, J. M. Opitz, and R. A. Raff gave this pithy evaluation of microevolution [short-term evolution]: "Microevolution looks at adaptations that concern only the *survival* of the fittest, not the *arrival* of the fittest" (my emphasis) in "Resynthesizing Evolutionary and Developmental Biology," *Developmental Biology* 173 (1996): 361.

[30]C. H. Williams, *Natural Selection, Domains, Levels and Challenges* (London: Oxford University Press, 1992) in G. L. G. Miklos, "Emergence of Organizational Complexities During Metazoan Evolution: Perspectives from Molecular Biology, Paleontology and Neo-Darwinism," *Mem. Ass. Australas Paleontols* 15 (Sept. 9, 1993): 26.

[31]J. S. Levinton, "The Big Bang of Animal Evolution," *Scientific American* 267 (November 1992): 84–91.

[32]Bowring, et al., estimated that the Cambrian explosion occurred in five to ten million years. See S. A. Bowring, J. P. Grotzinger, C. E. Isachsen, A. H. Knoll, S. M. Pelechaty, P. Kolosov, "Calibrating Rates of Early Cambrian Evolution," *Science* (September 3, 1993): 1293–8. Jablonski estimated a somewhat longer period: "During a relatively short period of 20 million years, all 37 major body plans in the animal kingdom—from sponges to vertebrates—arose" in D. Jablonski, "Developing a New View of Evolution," *Science* 277 (July 4, 1997): 37.

[33]The discovery of what is claimed to be a new phylum has been reported by P. Funch, and R. M. Kristensen, "Cycliophora is a New Phylum with Affinities to Entoprocta and Ectoprocta," *Nature* 378 (Dec. 14, 1995): 710–4. The significance of this discovery still needs to be determined.

[34]One of the most significant Cambrian animals, from the perspective of the human race, is a little, gracile creature named *Pikaia* found in the Burgess Shale and in China. Its unique body plan includes striated muscles and the notochord (which becomes the back bone and spinal cord in later progeny). It is considered to be the founding ancestor of all animals belonging to the phylum, Chordata, which includes all mammals and human beings. Thus the chordate body plan, shared by all members of our phylum, goes clear back to *Pikaia*, in the Cambrian explosion.

[35]C. Xiao, Y. Zhang, and A. H. Knoll, "Three-dimensional Preservation of Algae and Animal Embryos in a Neoproterozoic Phosphorite," *Nature* 391 (February 5, 1998): 553–8; Editorial comment by S. Bengtson, "Animal Embryos in Deep Time," *Nature* 391 (February 5, 1998): 529–30; and S. Bengtson and Y. Zhao, "Fossilized Metazoan Embryos from the Earliest Cambrian," *Science* 277 (September 12, 1997): 1645–8.

[36]C. -W. Li, J. -Y. Chen, and T. -E. Hua, "Precambrian Sponges with Cellular Structures," *Science* 279 (February 6, 1998): 879–82; and R. Kerr, "Pushing Back the Origins of Animals," *Science* 279 (February 6, 1998): 803–4.

[37]F. J. Ayala, A. Rzhetsky, and F. J. Ayala, "Origin of the Metazoan phyla: Molecular Clocks Confirm Paleontological Estimates," *Proceedings of the National Academy of Science USA* 95 (January 1998): 606–10.

[38]G. A. Wray, J. S. Levinton, and L. Shapiro, "Molecular Evidence for Deep Precambrian Divergences Among Metazoan Phyla," *Science* 274 (Oct. 25, 1996): 568–73.

[39]K. B. Miller, "The Precambrian to Cambrian Fossil Record and Transitional Forms," *Perspectives on Science and Christian Faith* 49 (December 1997): 264–7.

[40]It is, of course, to be expected that the Cambrian animals had precursors. See R. F. DeHaan, "Paradoxes in Darwin-

ian Theory Resolved by a Theory of Macro-Development," *Perspectives on Science and Christian Faith* 48 (September 1996): 154–63.

[41]S. J. Gould, "On Embryos and Ancestors," *Natural History* 107 (July/August 1998): 64.

[42]G. J. Vermeij, "Animal Origins," *Science* 274 (Oct. 25, 1996): 525–6.

[43]W. Arthur, *The Origin of Animal Body Plans*, 226.

[44]G. J. Vermeij, "Animal Origins," 526.

[45]Researchers are discovering how unbelievably complex the process of development is. See, for example, C. -H. Yuh, H. Bolouri, and E. H. Davidson, "Genomic Cis-Regulatory Logic: Experimental and Computational Analysis of a Sea Urchin Gene," *Science* 279 (March 20, 1998): 1896–1902.

[46]W. Arthur, *The Origin of Animal Body Plans*, 73; and R. A. Raff, *The Shape of Life* (Chicago: The University of Chicago Press, 1996), 33.

[47]When the Cambrian explosion is interpreted from the evolutionary perspective, it is often downplayed as a major discontinuity and played up as just another relatively minor event in the continuous history of animal life.

[48]D. H. Erwin, J. W. Valentine, and J. J. Sepkowski, "A Comparative Study Of Diversification Events: The Early Paleozoic Versus The Mesozoic," *Evolution* 41 (1987): 1177–86.

[49]Ibid., 1183. Herein lies the origin of the "top-down" and "bottom-up" metaphors.

[50]P. W. Signor, III, "Real and Apparent Trends in Species Richness Through Time," in J. W. Valentine, ed., *Phanerozoic Diversity Patterns: Profiles in Macroevolution* (Princeton: Princeton University Press, 1985), 148.

[51]J. W. Valentine, "Fossil Record of the Origin of Baupläne and Its Implications," in D. M. Raup, and D. Jablonski, eds., *Patterns and Processes in the History of Life* (Berlin: Springer-Verlag, 1986), 212.

[52]J. W. Valentine, "The Geological Record," in Th. Dobzhansky, "Species and Their Origins," 335.

[53]G. G. Simpson, "Periodicity in Vertebrate Evolution," *Junior Paleontology* 26 (1952): 359–70 quoted in K. Padian and W. A. Clemens, "Terrestrial Vertebrate Diversity: Episodes and Insights," in J. W. Valentine, ed., *Phanerozoic Diversity Patterns: Profiles in Macroevolution* (Princeton: Princeton University Press, 1985), 45–6.

[54]G. G. Simpson, *The Major Features of Evolution* (New York: Simon and Schuster, 1953), 237.

[55]A. Feduccia, "Explosive Evolution in Tertiary Birds and Mammals," *Science* 267 (1995): 638.

[56]R. Lewin, "A Lopsided Look at Evolution," *Science* 241 (July 15, 1988): 292.

[57]R. B. Goldschmidt, "Evolution as Viewed by One Geneticist," *American Scientist* 40 (1952): 91–2.

[58]G. G. Simpson, *The Major Features of Evolution* (New York: Columbia University Press, 1953), 238.

[59]Erwin, et al., "A Comparative Study Of Diversification Events," 1183.

[60]G. G. Simpson, *The Major Features of Evolution* (New York: Columbia University Press, 1953), 238.

[61]E. Mayr, *Animal Species and Evolution*, 600–1.

[62]Age determinations from studies of molecular clocks and from fossil results continue to disagree. See A. Gibbons, "Gene Put Mammals in Age of Dinosaurs," *Science* 280 (May 1, 1998): 675–6; and E. Pennisi, "Genome Data Shake Tree of Life," *Science* 280 (May 1, 1998): 672–4.

[63]W. Arthur, *The Origin of Animal Body Plans*, 256, 260, 14. As mentioned earlier, Arthur found it necessary to posit six hierarchies—three for ontogeny and the same three for phylogeny—morphological, genealogical, and genetic. That is, each can be found in individual embryonic development and in phyletic development. He warned, however, that the relationship between ontogenic and phyletic hierarchies is both complex and messy, rather than a neat, clean correspondence.

[64]J. W. Valentine and D. H. Erwin, "Interpreting Great Developmental Experiments: The Fossil Record," in R. A. Raff, and E. C. Raff, eds., *Development as an Evolutionary Process* (New York: Liss, 1987), 71.

[65]R. Chambers, *Vestiges of the Natural History of Creation* (1844, reprint, New York: Humanities Press, 1969), 202.

[66]"Mutants affecting early embryological stages survive only in the laboratory. An organism must survive as best it can with its given Bauplan" in J. Z. Young, *The Life of Vertebrates*, 3d ed. (Oxford: Clarendon Press, 1981), 14.

[67]R. A. Raff, *The Shape of Life* (Chicago: University of Chicago Press, 1996), 32, 434; B. Runnegar, "Evolution of the Earliest Animals," in J. W. Schopf, ed., *Major Events in the History of Life* (Boston: Jones and Bartlett, 1992), 87; and W. Arthur, *The Origin of Animal Body Plans*, 48.

[68]W. Arthur, *The Origin of Animal Body Plans*, 48.

[69]N. Pearcy, C. B. Thaxton, *The Soul of Science* (Wheaton, IL: Crossway Books, 1994), 248. They stated that "science and scholarship are never carried on in a philosophical and religious vacuum."

[70]M. Denton, *Evolution: A Theory in Crisis* (Bethesda, MD: Adler & Adler, 1986), 357.

[71]Two most vociferous exponents of this position are R. Dawkins, *The Blind Watchmaker* (New York: Norton, 1987) and D. Dennett, *Darwin's Dangerous Idea* (New York: Simon and Schuster, 1995).

Essay Reviews

Douglas Kelly on the Framework Interpretation of Genesis One

CREATION AND CHANGE: Genesis 1.1–2.4 in the Light of Changing Scientific Paradigms by Douglas F. Kelly. Ross-shire, Great Britain: Mentor, 1997.

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Douglas Kelly is Professor of Systematic Theology at Reformed Theological Seminary, Charlotte, NC. His *Creation and Change* is an apologetic defense of young earth creationism, with a special emphasis on the question of the age of the earth/universe. While he includes a few critical remarks about biological evolution, Kelly's primary aim is to refute the old earth/universe viewpoint, especially as held by evangelical Christians, whom he disparagingly calls "evolutionary evangelicals."[1]

On the "scientific" front there is little new here. Since Kelly professes that he is "a theologian and student of the Bible, and in no sense a scientist," he relies heavily on the arguments of well-known young-earth apologists. He frequently quotes the writings of Henry Morris, Walter Brown, R. L. Wysong, Paul Ackerman, and Robert Whitelaw. This part of the book, however, is marred by Kelly's failure to interact with the body of literature that seeks to set the record straight on these points.

On the exegetical front, Kelly attempts to refute the evangelical nonliteral interpretations of the days of Genesis 1. He addresses the day-age view, the gap theory, and the framework interpretation espoused recently by Meredith G. Kline in this journal.[2] Since an entire chapter (chap. 6) is a critique of the framework view, and since Kelly's critique is being appealed to by many young-earth defenders in conservative evangelical circles, this review will focus on the hermeneutical concerns raised by Kelly.

Referring to nonliteral approaches to the days of Genesis 1, such as Kline's framework interpretation, Kelly charges that "exegetes have to engage in a sort of modern casuistry to make Genesis 'day' mean anything other than ordinary solar day" (p. 112). One repeatedly encounters in Kelly and those of his camp the opinion that an honest and unprejudiced examination of the text can only lead to the literal, young-earth position. Yet, at the same time, Kelly recognizes that certain features of the text are not consistent with the literal solar day interpretation. For example, the observation—as ancient as Augustine's *Literal Interpretation of Genesis*—that the first three days could not have been solar days for the simple reason that the sun was not created until day four, is noted as an argument "of serious moment." But apparently it is not so momentous that a quick quote from Henry Morris reasserting the "straightforward understanding of all seven days as normal days of the same length" cannot obviate the difficulty (p. 111).

Another example of Kelly's out-of-hand dismissal of the exegetical evidence for a nonliteral approach is his treatment of the argument that, according to

Heb. 4:1–11, the seventh day is an open-ended, eternal day. Given the fact that the seventh day is an integral part of the unitary creation week it would be reasonable to ask, "If 'day' can be used in a nonordinary, nonsolar sense for day seven, why must we insist that the previous six occurrences can only refer to ordinary, solar days?" Kelly simply raises this question and then dismisses it with a cavalier wave of the hand and appeals again to the "patent sense" of the text (p. 111). These examples should give the reader an idea of the quality of the author's biblical scholarship. Ironically, it was here that Kelly claimed to be at his best. It would appear that the charge of "modern casuistry" is more applicable to Kelly than to his nonliteral counterparts (whether framework or day-age).

When Kelly aims his guns specifically at Kline's position, the quality of his scholarship declines still further. Kelly does not object to the framework interpretation merely because it leaves room for an old earth/universe. In his estimation, it involves something far more serious: the introduction of a disastrous disjunction between historical factuality and literary form. "Much more is at stake here than the admittedly complex question of how old the earth is. Even if one wished to opt for an ancient cosmos, the mode they have chosen to achieve it is too high a price to pay in terms of the truth claims of the entire biblical text" (pp. 114–5).

But the charge of a dangerous "hermeneutical dualism" between historical factuality and literary form is unfounded, for it is really Kelly who is guilty of such dualism. Evangelical advocates of the framework interpretation, like Kline, have always insisted that the creation account of Genesis inerrantly records actual historical events—events which really occurred in space and time. However, these events have been narrated in a nonsequential, topical order under the framework of a week of "days." The days are like picture frames. Within each picture frame, the Holy Spirit has inerrantly recorded various scenes of God's creative activity as he fashions the formless and void world into an orderly cosmos to be a replica of his heavenly dwelling place. Even though the picture frames (the days) are not literal solar days, the picture within each frame is to be interpreted as referring to historical events in the visible world. Thus, there is no tension between the historicity of the text (the creative acts) and its literary form (the creation "week"). The two aspects of the text are perfectly harmonious; there is no dualism. The charge of hermeneutical dualism, therefore, must be placed at Kelly's feet. His inability to fathom how both literary form and historical factuality can harmoniously co-exist in Genesis 1 shows that it is he who dualistically pits one against the other.

In addition to this strange case of the pot calling the kettle black, Kelly descends into still further obscurity by accusing the framework view of being both Platonic and nominalist (p. 116)! Plato's realism and Ockham's late medieval nominalism are normally thought of as being significantly opposed to one another. Based on the length of his discussion of nominalism, however, it would appear that Kelly would probably go with the latter charge if push came to shove. The basic argument is this. Nominalism (as Kelly understands it) teaches that human words have no proper referential reality outside the mind. The framework interpretation says that the "days" are figures of speech, and thus mere mental ideas or literary devices. Therefore, the framework interpretation is guilty of the medieval heresy of nominalism.

Although one suspects foul play at this point, I will make no effort to question the accuracy of Kelly's grasp of late medieval linguistic theory. However, we must ask how Kelly would clear *himself* of the charge of nominalism, given his own definition of it. He admits that there are instances where *yom* (day) is used in a nonliteral sense: "There are a few Scriptural texts which make it clear that 'day' is being employed in another sense than 'twenty-four hours'" (p. 108; examples cited: Gen. 30:14; Job 7:6; Ps. 90:9; 2 Pet. 3:8). And what about the myriad of examples in Scripture where figurative, poetic, and nonliteral language is used? I doubt that Kelly wants to reject all nonliteral interpretations of Scripture as nothing more than nominalism.

Another argument of Kelly's is based on the slippery slope fallacy. He argues that it would be naive to suppose that a nonliteral approach "could be stopped at the end of the second chapter of Genesis, and would not be employed in other texts that run contrary to current naturalistic assumptions" (p. 115). The problem, according to Kelly, is that this literary approach to Genesis 1 has no brakes. What would prevent someone less orthodox than Kline from applying the same hermeneutic to the virgin birth or the resurrection of Christ?

But let's turn the tables for a moment. Many fundamentalists used to argue that the amillennial and postmillennial views—both of which interpret the "thousand years" of Rev. 20 in a nonliteral manner—would lead down the slippery slope to liberalism. Kelly is a postmillennialist and believes that the "thousand years" of Rev. 20 do not refer to a literal,

one thousand year period of time. What are the exegetical brakes preventing Kelly from applying this nonliteral hermeneutic to deny the resurrection of Christ? Presumably, Kelly is persuaded of a nonliteral interpretation of Rev. 20 because he has concluded, after a careful study of biblical eschatology, that the Scripture does not teach that there will be an earthly millennium after Christ returns; that, in fact, there is only one resurrection of both the righteous and the unrighteous (Dan. 12:2; John 5:29); and that the eternal state will follow immediately after the second coming, leaving no room for a postadvental but pre-consummation millennial period (1 Cor. 15:23–28; 2 Pet. 3:9–13). Based on these texts, therefore, non-premillennialists hold that the thousand years is an idealized figure representing the entire interadvental period. However, there are no similar legitimate arguments for taking the resurrection or the virgin birth figuratively. In other words, the exegetical brakes preventing Kelly from sliding down the slippery slope into outright liberalism is his commitment to interpreting each text in light of the total context of Scripture.

This hermeneutical procedure of comparing Scripture with Scripture (also known as the analogy of Scripture) is the same method used by the framework interpretation. The framework view appeals to several exegetical features of the text that favor, or even require, a nonliteral interpretation of the days. For example, there is the striking parallelism between days 1–3 (which narrate the institution of the creation kingdoms: light/darkness; sky/seas; land/vegetation) and days 4–6 (which describe the creation of the creature kings, respectively: luminaries; birds/fish; animals/humans). The parallelism between each corresponding member of the two triads indicates the presence of intentional literary artistry.

Furthermore, we have already alluded to the argument that the seventh day is clearly not an ordinary, solar day. And yet it is called a "day," just like the previous six. Kelly rejects the view that the seventh day is eternal but gives no alternative explanation of Heb. 4:1–11—a passage that clearly equates the seventh day of creation (v. 4) with the Sabbath rest that *currently* "remains for the people of God" to enter by faith (v. 9). Others accept this biblical-theological argument, but maintain that the other six days are still literal. But this approach fails as well. How can the creation week be dismembered in this fashion? The entire week of seven days is a unified whole. If one member of that week is a nonsolar day, it would be utterly arbitrary to insist that the others are solar. Besides, as Augustine has pointed out, the first three days cannot be solar days. So what we really have is four nonsolar days and only three (allegedly) solar ones.

In view of this kind of powerful exegetical evidence, are we not justified in taking the whole "week" as a figurative framework for organizing the divine creative activity in a topical manner? This hermeneutic is not Platonism, nominalism, or dualism. It is not the first step down the slippery slope to a denial of the virgin birth. It is simply basic scriptural exegesis grounded in time-honored exegetical principles and the presupposition that Scripture, as the inerrant and inspired Word of God, is its own best interpreter. Exegetically, there are compelling, if not decisive, grounds for concluding that the days of Genesis are not literal solar days.[3] Kelly has not given the intelligent reader any good reasons to think otherwise.

In conclusion, Kelly's attempt in *Creation and Change* to refute the nonliteral framework interpretation of Genesis 1 must be regarded as an abysmal failure. His claim that the framework interpretation constitutes a serious departure from evangelical fidelity to Scripture remains unproved. If this most recent volley in the Genesis debate is any indication, it would appear that the framework interpretation is substantially more difficult to refute than its critics have imagined. ✯

Notes

[1]In Kelly's over-generalizing lexicon, this epithet includes those evangelical Christians, such as Hugh Ross and Meredith G. Kline, who acknowledge the strength of the empirical evidence for an old earth/universe—a position that does not necessarily imply an evolutionary explanation of biological origins in general—and who have biblical objections to an evolutionary origin for humans in particular.

[2]Meredith G. Kline, "Space and Time in the Genesis Cosmogony," *PSCF* 48:1 (March 1996): 2–15.

[3]For a more complete treatment of the exegetical evidence, cf. M. G. Kline, op. cit.; Mark D. Futato, "Because It Had Rained: A Study of Gen. 2:5–7 With Implications for Gen. 2:4–25 and 1:1–2:3," *Westminster Theological Journal* 60:1 (Spring 1998): 1–21; and Lee Irons with Meredith G. Kline, "The Framework Interpretation," in *The Genesis Debate: Three Views on the Days of Creation*, edited by David G. Hagopian (Crux Press), forthcoming.

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Paradigm Shifts in Geology and Biology: Geosynclinal Theory and Plate Tectonics; Darwinism and Intelligent Design‡

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The years 1857–1859 were seminal years for theory proposals. In 1859, Darwin published his "theory of natural selection" to replace the reigning paradigm of "intelligent design." According to Francisco Ayala, before Darwin:

> the functional design of organisms and their features seemed to argue for the existence of a designer. It was Darwin's greatest accomplishment to show that the directive organization of living beings can be explained as the result of a natural process, natural selection, without any need to resort to a Creator or other external agent.[1]

Ayala further clarifies the opposing paradigms by stating:

> Darwin's theory encountered opposition in religious circles, not so much because he proposed the evolutionary origin of living things (which had been proposed many times before, even by Christian theologians), but because his mechanism, natural selection, excluded God as the explanation accounting for the obvious design of organisms.[2]

Despite both religious and scientific objections, by 1960 Darwin's mechanism of natural selection had completely triumphed over the concept of intelligent design as the explanation accounting for the "obvious design of organisms."[3]

In 1857, during an American Association for the Advancement of Science (AAAS) meeting, James Hall, a respected paleontologist, proposed a theory to explain the origin of mountains and their thick packages of sediments. The idea, later supplemented by J. D. Dana, was that a huge trough-like depression, known as a geosyncline, became filled with sediments and subsided until it gradually became unstable and, with heat from the interior of the earth, was crushed, folded, and elevated into a mountain chain. Geosynclinal theory, while dynamic in the vertical plane, was essentially a static model of the earth's crust with respect to its horizontal plane—a crucial distinction which set it apart from the theory of continental drift. As late as 1960, geosynclinal theory reigned as the established theory with the concept of continental drift being largely ignored (or ridiculed) by geologists working in the northern hemisphere.

In 1859, Antonio Snider, who had noticed the remarkable jigsaw-puzzle fit of the continents—especially that of Africa and South America—proposed the hypothesis of continental drift (the precursor to plate tectonics). In the early 1900s, meteorologist Alfred Wegener developed Snider's concept into a coherent hypothesis. To Snider's jigsaw-puzzle fit of the continents, Wegener added impressive lines of

‡*This paper was presented at the 52nd Annual Meeting of the ASA in Santa Barbara, CA on August 4, 1997.*

**ASA Fellow*

evidence from ancient rock matches, glaciation, mineral belts, mountain ranges, and fossil sequences. By 1950, evidence that supported the hypothesis of continental drift included:

1. The jigsaw-puzzle fit of the continents (especially when continental slopes were taken into account).

2. Matching ancient rock sequences, mineral belts, and mountain ranges across the continents (see Figure 1). The late Paleozoic and early Mesozoic rock sequences matched the southern continents like the pages of a book torn in half. Further, the more recent Cenozoic layers were different in both composition and stratigraphic sequence.

3. Ancient (late Paleozoic and early Mesozoic) animal and plant fossils were similar, while Cenozoic fauna and flora were dissimilar, just as today's African flora and fauna are distinct from those of South America.

4. Ancient (Permian) glacial till match-up, plus the direction of glacial striations, agreed when all of the southern continents including India, Australia, and Antarctica were put together.

5. Paleoclimatic and paleomagnetic data indicated that either the poles or the continents had moved. This was especially true for North America and Europe. The latter inference was far more consistent with the data, because it assumed only one north pole, whereas the former required the postulation of two north poles. (Rocks in North America pointed to a position for the ancient north pole that was geographically widely separated from that to which rocks in Europe pointed.) More important, the continual movement of even one magnetic pole about the globe was doubtful scientifically. A more logical conclusion was that the continents (rather than one or more magnetic poles) had moved.

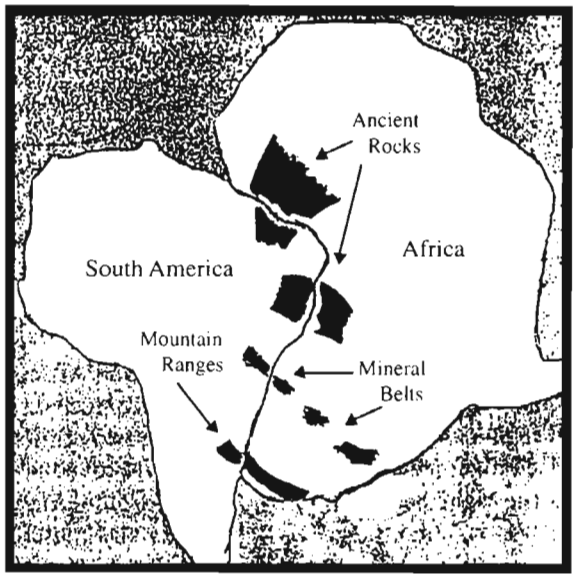

Fig. 1. Continental fit and ancient rock, mineral belt, and mountain range matches between South America and Africa.

Yet, despite this substantial evidence for continental drift, geologists largely ignored or scorned this hypothesis. Why? The most frequently cited reasons include the fact that most geologists were working in the northern hemisphere (where the evidence was less obvious) and that continental drift lacked a mechanism (later to be known as sea floor spreading) to move the continents through the more rigid, dense sea floor. (The fact that geosynclinal theory also lacked a testable mechanism was not noted until after the triumph of plate tectonics.) The sociological reasons often mentioned for the ridicule of continental drift include the fact that Wegener was not a geologist (How dare a mere meteorologist propose a geological theory?), and furthermore, he was a German. Post-World War I animosities still existed in professional circles.

However, I suggest that the main reason that continental drift was ignored or scorned was the power of the "established" geosynclinal theory (the static, rather than mobile, continent paradigm) to blind the geologic community to new ways of thinking. So powerful was the established geosynclinal theory that the 1960 edition of Clark and Stearn's *Geological Evolution of North America* compared the status of geosynclinal theory, which was thought to explain "the origin of mountains from geosynclines," with Darwin's theory of "the origin of species through natural selection":

> The geosynclinal theory is one of the great unifying principles in geology. In many ways its role in geology is similar to that of the theory of evolution which serves to integrate the many branches of the biological sciences. The geosynclinal theory is of fundamental importance to sedimentation, petrology, geomorphology, ore deposits, structural geology, geophysics, and in fact all branches of geological science. It is a generalization concerning the genetic relationship between the trough like basinal areas of the earth's crust which accumulate great thicknesses of sediment and are called geosynclines, and major mountain ranges. Just as the doctrine of evolution is universally accepted among biologists, so also the geosynclinal origin of the major mountain systems is an established principle in geology.[4]

Within ten years following the publication of the above geology textbook, geosynclinal theory was re-

placed by the theory of plate tectonics (which combined the hypotheses of continental drift and sea floor spreading). Key to the success of this paradigm revolution was the 1962 proposal of Harry Hess of Princeton, that the continents and ocean crust move together driven by the mechanism of thermal convection in the mantle. In 1963, the death knell of geosynclinal theory was sounded when Vine and Matthews published their model of magnetic-stripe evidence for sea floor spreading which confirmed the Hess hypothesis. The sea floor itself was spreading apart at the mid-oceanic ridges, carrying their attached continents further and further away from one another. The collisions between plates were the major explanations for the formation of major mountain ranges. It then became obvious to most geologists that geosynclinal theory had never possessed a testable explanatory mechanism for explaining the origin of major mountain ranges.

Can biology learn from this lesson of paradigm replacement in geology? I would hope so. While the neo-Darwinian mechanism (the mutation-selection hypothesis) is well established as an explanation for both the variation within species and the origin of new species, whether it explains the origin of major innovations, such as higher level taxon, is an open question that few Darwinists will acknowledge. While many scientists recognize the benefits of multiple working hypotheses, Darwinists prevent the hypothesis of intelligent design from being considered. Their dismissal of design theory is reminiscent of the pre-1960 ridicule of continental drift. Lines of evidence that may cast doubt on neo-Darwinism and favor intelligent design (or some other mechanism) as the explanatory mechanism for the origin of major innovations (complexity) include:

1. Patterns of the origin of major innovations in the fossil record (i.e., the origin of the animal phyla in the 40 million-year-long Vendian revolution/Cambrian explosion).

2. Irreducible complexity, especially at the molecular level.[5]

3. The apparent inability of natural causes (chance and necessity) to account for the origin of complex specified information.[6] In essence, the informational content in DNA appears to transcend and is not dependent upon the properties of its material medium. In an analogy to language, the physio/chemical properties of the neucleotide sequences do not explain the origin of information contained therein.[7]

In any event, I hope that biologists can learn from the humbling lessons of geology and consider the possibility that old theories—especially those that protect the philosophy of naturalism—may be hindering the search for truth. Conversely, design theorists should recognize that the key to consideration of their proposal lies in the development of rigorous methods for detecting intelligent design or exclusion of natural causes or both. ★

Notes

[1]Francisco J. Ayala, "Darwin's Revolution," in J. H. Campbell & J. W. Schopf, *Creative Evolution!?* (1994), 4.

[2]Ibid., 5. It should also be noted that Ayala insists that the haphazard nature of the fossil record describes events that "are not compatible with a preordained plan, whether imprinted from without by an omniscient and all-powerful Designer, or the result of some necessitating force driving the process toward definite outcomes. Biological evolution differs from a painting or an artifact in that it is not the outcome of a design preconceived by an artist or artisan" (p. 16). This position was reiterated by Ayala in his lecture, "Darwin's Devolution: Design Without Designer," at the John Templeton Foundation Science and Religion Course Program, hosted by The Center for Theology and the Natural Sciences, January 18, 1998.

[3]While Ayala refers to the "obvious design of organisms," Francis Crick states that "Biologists must constantly keep in mind that what they see was not designed, but rather evolved" (*What Mad Pursuits* [New York: Basic Books, 1988], 138). Thus, Crick agrees on the main point: Darwin's mechanism of natural selection replaced the concept of intelligent design as the creator of organisms which appear to be designed. Richard Dawkins, who occupies the Charles Simonyi Chair of Public Understanding of Science at Oxford University, states the case as follows:

> Biology is the study of complicated things that give the appearance of having been designed for a purpose. . . . Natural Selection, the blind, unconscious, automatic process which Darwin discovered, and which we now know is the explanation for the existence and apparently purposeful form of all life, has no purpose in mind (*The Blind Watchmaker* [New York: Norton, 1986], 1 and 5 respectively).

Similarly, the marketing flyer for the BBC video, *The Blind Watchmaker*, states that "the beautiful complexity of living things" was not produced by "an intelligent designer like God" but rather by "Evolution, the Blind Watchmaker."

[4]T. H. Clark and C. W. Stern, *Geologic History of North America* (1960), 43.

[5]See Michael J. Behe, *Darwin's Black Box* (New York: The Free Press, 1996).

[6]See William A. Dembski, "Intelligent Design as a Theory of Information," *Perspectives on Science and Christian Faith* 49, no. 3 (1997): 180–90.

[7]See Stephen C. Meyer, "The Origin of Life and the Death of Materialism," *The Intercollegiate Review* 31, no. 2 (1996): 24–43.

Creation Science and Caring for the Creation in Korea‡

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Since the early 1970s, when rapid industrialization accelerated the deterioration of the environment in Korea, some Korean Christians have become concerned about caring for the creation. As a result, several Christian organizations, such as "Korea Christian Ethics Movement," "Citizens Council of Economic Justice," "Ecclesiastical Institute for Environmental Studies" and YMCA, have started to lead environmental movements by setting up environmental divisions in their organizations.

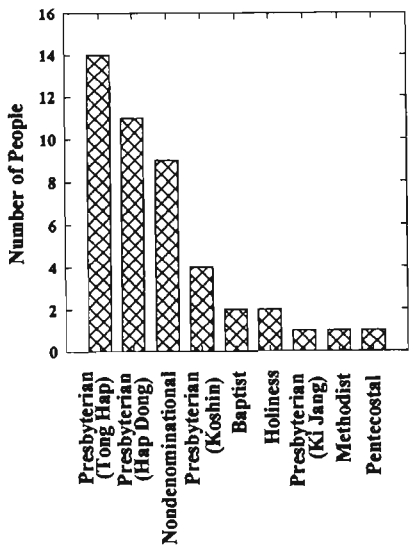
In this paper, I will analyze the attitude of Korean creation scientists toward environmental issues.[2] By surveying their theological positions, I attempt to trace the origin of their attitude toward environmental issues.

For this study, I selected members of the Korean Association for Creation Research (KACR), an association of creation scientists with about two thousand members (about two hundred with doctorates). I made a questionnaire that consisted of seven questions about their activities in creation science, their theological positions, and their environmental concerns. The questionnaire was sent to 67 members who are actively propagandizing creation science, by public lectures and writing. Forty-five responded.

Background of Creation Scientists in Korea

Figure 1 shows that the denominational distribution of the creation scientists who responded is roughly proportional to the relative size of the denomination. It means that creation science was accepted without any denominational preference, at least in Korea. Regardless of the theological doctrines of their denominations, most lay Christians in the Korean church are quite conservative. This is in contrast to the United States where many leading creation scientists come from the Southern Baptist, the Seventh-Day Adventist, and other conservative denominations.

Fig. 1. Denominational Distribution



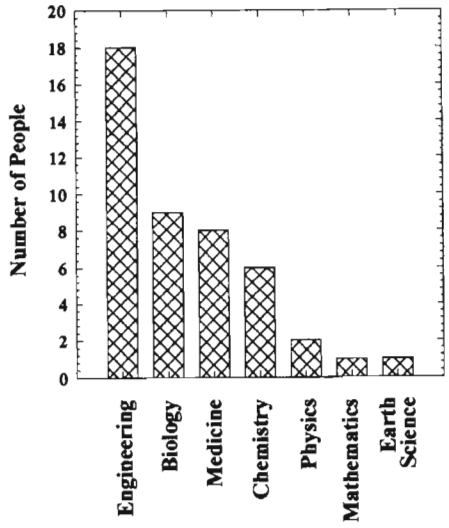
The distribution of Korean creation scientists by discipline is somewhat similar to the American creation scientists. As shown in Figure 2, there are eighteen engineers, nine biologists, eight medical doctors,

‡*This paper was presented at the 51st Annual Meeting of the ASA and the CSCA in Toronto, Canada on July 27, 1996.*

**ASA Member*

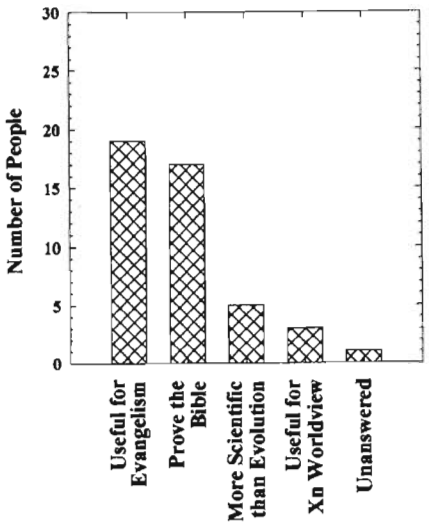
six chemists, two physicists, one mathematician and one earth scientist. It is quite interesting that scientists from applied science or engineering are dominant. Even people in biology, who work in fields like genetic engineering, biochemistry, and so forth, are represented. Dr. Kim Young-Gil, President of the KACR, is a famous metallurgist.[3]

Fig. 2. Disciplinary Distribution



The academic background of creation scientists in applied science is reflected in their understanding of the primary importance of creation science. As indicated in Figure 3, only four selected "More Scientific than Evolution" in the question asking about the primary importance of creation science. Nineteen selected "Useful for Evangelism" and seventeen, "Prove the Bible."

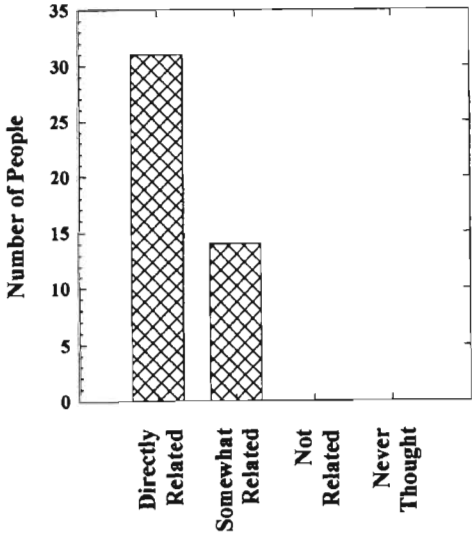
Fig. 3. Primary Importance of Creation Science



Attitude of the KACR Toward Environmental Concerns

Then what is the attitude of the KACR toward environmental concerns? As shown in Figure 4, twenty-nine creation scientists answered that creation science "Directly Related" to environmental issues and fourteen responded "Somewhat Related." None said "not Related" or "Never Thought about It." Despite individual concern, however, the KACR seems to be consistently indifferent to environmental issues in terms of its activities.

Fig. 4. Environmental Connection of Creation Science



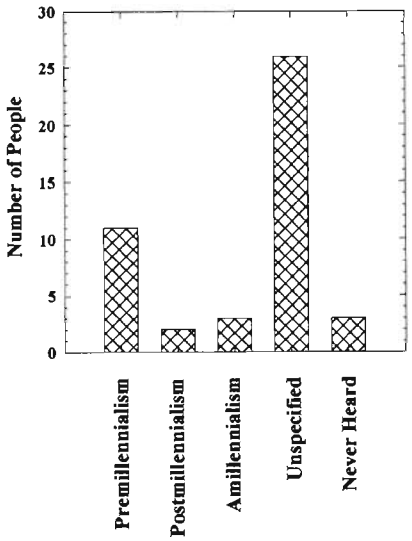
Since its inception in 1981, the KACR's primary focus has been in the following activities: giving public lectures, revising high school science textbooks, raising money for a creation science exhibition center, running a publishing company, funding several projects to prove the scientific validity of biblical descriptions, and even hosting two international conferences. But strangely enough, the KACR has been quite indifferent to environmental issues which are related to God's creation. Then the question arises about why this is the case.

(1) Premillennial Atmosphere: Above all, creation science in Korea has been supported by some "otherworldly theologies" in eschatology, God's revelation, and biblical hermeneutics. In particular, eschatology is important to characterize the Korean creation scientist's attitude toward environmental concerns.

For a question about millennialism, Figure 5 shows that eleven Korean creation scientists support

premillennialism, two postmillennialism, three amillennialism, and twenty-nine do not have any specific view or "Never Heard or Never Thought about It." But it seems to me that the KACR implicitly follows the premillennial orientation of the Institute for Creation Research (ICR) in Santee, CA.[4] For example, Dr. Kim Young-Gil was influenced in becoming a Christian by Hal Lindsay's best-selling premillennial book, *The Late Great Planet Earth*.[5]

Fig. 5. Millennialism



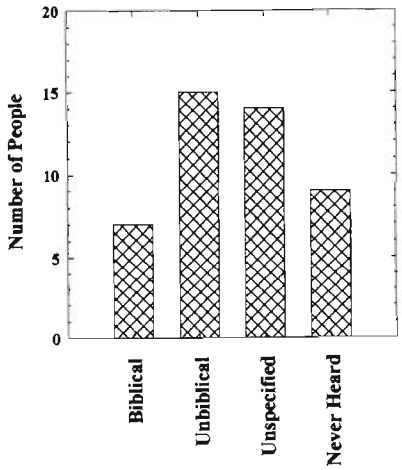
According to the premillennialist, "the kingdom of Christ will be inaugurated in a cataclysmic way" and "divine control will be exercised in a more supernatural manner than does the postmillennialist." The divine control is "established suddenly through supernatural methods rather than gradually over a period of time by means of the conversion of individuals." "Christ will restrain evil during the age by the use of authoritarian power."[6] The premillennialists, whose major concern is the millennium in heaven, are not concerned much with activities which would improve the world, such as social and economic justice and environmental concerns.

Such characteristics of premillennialism are quite similar to those of creation science, which claim the supernatural fiat and a sudden creation of the universe rather than a gradual development over a vast period of time. Although most Korean creation scientists who responded do not know the specific theological arguments of each millennialism, their view of this world is quite premillennial.[7]

It is very interesting that some minor denominations, which are usually charged as heresies by orthodox churches, are premillennial and support creation science. For example, the Seventh-Day Adventist, the Jehovah's Witnesses, and the Mormons usually equate their activities with the coming of the millennium.[8] In particular, the Seventh-Day Adventists, the originators of creation science, believe "the millennium is the thousand-year reign of Christ with his saints in heaven between the first and second resurrections."[9]

(2) Dispensationalism: Many American leaders of creation science come from a dispensationalist background.[10] The beginning of the KACR was much influenced by the ICR, which supports dispensationalism. As shown in Figure 6, however, most Korean creationists do not support or are not concerned about it, except for its hermeneutical principle. One essential characteristic of a dispensational theology is "a consistent use of the hermeneutical principle of normal, plain, or literal interpretation."[11]

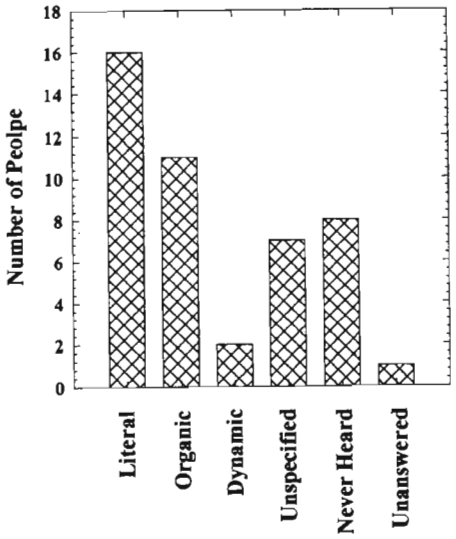
Fig. 6. Dispensationalism



(3) Literal Inspiration of the Bible: As shown in Figure 7, "literal inspiration" is the most popular view on the Bible. Many Korean creation scientists did not follow their denomination's official position about the inspiration of the Bible. Although most Presbyterian and Methodist churches support a "dynamic inspiration" of the Bible, thirteen from those denominations support a "literal inspiration."

Those who believe that the Bible was literally inspired do not accept that the Bible directly and explicitly indicates the importance of environmental concerns. They understand that if there is no explicit reference to caring for the creation, they are not responsible for it.

Fig. 7. Inspiration of the Bible



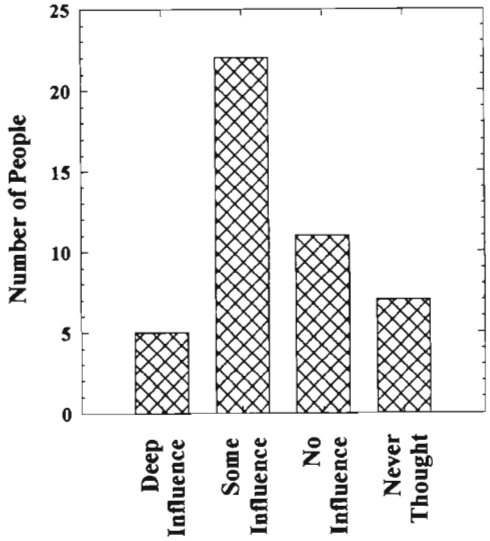
As mentioned above, most Korean creation scientists come from conservative denominations that, although gradually changing their attitudes toward environmental issues, discourage the discussion of Christian stewardship for the environment in creationism forums. The only exception is Dr. Kim Jung Wook, professor of environmental science in Graduate School of Environment, Seoul National University. But it seems that his active concern does not come from his creation science belief, but from his profession.

As shown in Figure 1, twenty-seven of the forty-five leading Korean creation scientists come from quite conservative Presbyterian churches. Conservative denominations include some Presbyterian (Tonghap, Hapdong, Koshin, etc.) churches, the Holiness churches, Baptist churches (including Southern and Bible Baptist), the Full Gospel churches, and even Seventh-Day Adventist churches.

So far, the Christian implications of environmental concerns have been actively discussed within a few "moderate" denominations, such as the Methodist, part of the Presbyterian (Ki Jang), the Anglican, and the Catholic churches. As shown in Figure 1, however, only two of the creation scientists who responded belong to these denominations.

(4) Poor Communication: In addition to the conservativeness and otherworldliness of the Korean church and its theology, the Korean creation scientists have poor communication with theologians and Christian academics, who could provide various environmental implications of creationism. They have been excluded from the creationism forum, because, from the beginning, the KACR has limited its membership to Christians with masters or doctoral degrees in science and engineering. Poor communication is shown in the question asking about the influence of the theological position of creationism. As shown in Figure 8, only five answered "Deep Influence." It is contrasted with the American creation scientists' camp in which creation scientists actively interact with the theological community.

Fig. 8. Influence of Theological Positions on Creationism



In summary, although individual creation scientists have deep concerns about caring for the creation, the KACR is not actively concerned about it. From the responses to the question about the influence of their theological position on creationism, it seems that their individual concern toward environmental issues does not come from their creation science belief but from other sources. Indifference toward caring for the creation seems to result from the conservativeness of Korean churches and from the poor communication of the Korean creation scientists with other disciplines. ✯

Notes

[1]Paul Seung-Hun Yang resigned from his professorship at Kyungpook National University and moved to Vancouver, BC to start the Vancouver Institute for Evangelical Worldview, a branch ministry of Disciples with Evangelical Worldviews, an organization of evangelical Christian scholars.

[2]By creation scientist, I mean someone who would generally hold the view of the Institute for Creation Research in the United States.

[3]On February 22, 1997, Kim Young-Gil retired and Song Man Seok, professor of computer science at Yonsei University, was elected as the new president.

[4]For millennialism, see R. G. Clouse, "Dispensation, Dispensationalism," *Evangelical Dictionary of Theology*, Walter A. Elwell, ed. (Grand Rapids, MI: Baker, 1984), 715.

[5]Hal Lindsay, *The Late Great Planet Earth* (Grand Rapids, MI: Zondervan, 1970).

[6]Clouse, *Evangelical Dictionary of Theology*, 715.

[7]According to Han Jung Gun, Presbyterians, occupying more than 80% of Korean Christians, did not choose a specific position about the millennium and their position varies from person to person. Cf. Han Jung Gun, *Biblical Perspectives on the Modern Eschatology* (CLC, Seoul) and *An Introduction to the Eschatology* (CLC, Seoul).

[8]Clouse, *Evangelical Dictionary of Theology*, 715.

[9]*Seventh-Day Adventists Believe: A Biblical Exposition of 27 Fundamental Doctrines* (Washington, DC: General Conference of Seventh-Day Adventists, 1988), chap. 26.

[10]For example, the ICR, Grace Theological Seminary, and the Seventh-Day Adventists (major originators of creation science) support dispensationalism.

[11]C. C. Ryrie, "Dispensation, Dispensationalism," *Evangelical Dictionary of Theology*, 322.

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.) Richard Ruble, Book Review Editor, *Perspectives on Science and Christian Faith*, 212 Western Hills Drive, Siloam Springs, AR 72761

Michel Blay, *Reasoning with the Infinite: From the Closed World to the Mathematical Universe*, University of Chicago Press, 1998

John Brooke and Geoffrey Cantor, *Reconstructing Nature: The Engagement of Science and Religion*, T & T Clark, 1998

Beatrice Bruteau, *God's Ecstasy: The Creation of a Self-Creating World*, Crossroad, 1998

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The Image of God and Human Biology

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"... So God created man in his own image, in the image of God he created him; male and female he created them" (Genesis 1:27, RSV).

As a biological scientist who believes that God's Word has some significant things to tell us about ourselves, I have always found it appealing to contemplate the prospect of finding a correspondence between biblical revelation on human origins and the growing body of evolutionary evidence accumulated by paleoanthropologists. However, it was not until I recently began to research the evolution of human cognition that the possibility of making that connection began to show some signs of hope.

For most of my professional life, I have held to the theory that the origin of humans as biological beings came about by an entirely different creative process than did that which we identify as the human soul. That is, there is no legitimate reason to presume that the revelation from Genesis 1 quoted above must be interpreted to suggest that the unique status modern *Homo sapiens* possess in relationship to the Creator was acquired in parallel with the physical attributes that distinguish them from other creatures. The image of God is a uniquely human attribute that most probably came about as the result of a unique, nonevolutionary creational event. How and when that event may have taken place has remained a matter of considerable debate.

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The literature of paleoanthropology provides a prospective time line for the evolutionary development of modern humans from our earliest hominid ancestor. This time line suggests a period of about six million years for the process. No fossil evidence is currently available dating as far into the past as the proposed "first hominid," but data are available beginning about 4.5 million years ago. Using those data, and noting the progress of developing mental function with time (using advances in hominid technical skills to measure developing cognitive capacity), it is possible to picture how mental capability increased among our prehuman ancestors as evolutionary development progressed.

For example, the simplest stone tools did not even appear on the scene until hominid development had been underway for more than three million years. After that, it required another 2.5 million years for paleolithic technology to advance from fragments of smashed quartz pebbles to fashioned prismatic stone blades. Clearly, the development of technical skill was progressing consistently over those millions of years—but at a painstakingly slow pace.

Looking even farther back in evolutionary time, and imagining the progress of events over the several billion years that led from the primordial soup to the emergence of the first hominid, the rate of development of human mental capacity (at least throughout most of the six million years over which it is presumed to have occurred) does not appear to be out of line with that of developmental progress over all of evolutionary time. Evolution has been a slow and consistent process, exhibiting measurable progress only because the times involved were so very large.

With these facts in place, we can look at the kinetics of evolutionary progress and draw some conclusions about any anomalies that may exist. The assumptions implicit in evolutionary theory suggest that it—like many processes it engendered—is essentially autocatalytic. That is, the rate of evolutionary change would be expected to be generally proportional to the occurrence of prior change. Progress begets progress. The kinetics of such an autocatalytic process yield a relationship in which evolutionary advances would be expected to proceed along a curve that increases exponentially with time. Obviously, it is not possible to plot explicit quantities on a graph to derive a relationship between evolutionary progress and evolutionary time. Yet, a clear

sense of the kinetics involved can be pictured in concept, and if any significantly large anomalies are observed, it should be possible to draw some valid conclusions about when those anomalies occurred.

The fossil record over most of evolutionary history is too fragmentary to allow, even in concept, an analysis of the kinetics of evolutionary progress. However, when we consider the observed advances in cognitive capability among the immediate progenitors of modern humans, the evidence is totally consistent with the suggestion that, over all but a minutely fractional period at the end of those six million years, the developmental kinetics of human cognition were autocatalytic. That is, paleolithic technology was essentially unmeasurable for the first half of that period, and then increased slowly in rate as hominid evolution progressed to produce modern *Homo sapiens*.

Then, about forty to sixty thousand years ago, the rate of evolutionary progress—at least as it relates to human technological capability—experienced a discontinuity of colossal proportions. The rate constant increased by orders of magnitude in what has to be considered an evolutionary instant—perhaps even an instant in real time.

Given the obviously minute rate constants that were operative over all but this final moment of evolutionary history, there is no easy way to explain the explosive increase in human cognitive capacity documented over the last forty or so millennia. Certainly, any explanation of how it came to be has to acknowledge that its occurrence was historically anomalous. Speculations about possible mechanisms that invest modern humans with their unique capacity for such things as creativity, self-image, logical thought, and aesthetic appreciation must allow the very likely possibility that these faculties came into being because of an instantaneous acquisition in the recent past, rather than as the result of a slow, methodical evolutionary progression.

This event was, in a very real sense, a "cognitive big bang"—the sudden and dramatic appearance of a sophisticated human capacity for cognition at a time when evolution had finally invested *Homo sapiens* with the necessary biological equipment to sustain it. That point in time in which this kinetic anomaly is observed to have occurred may be the instant in human history at which humans were uniquely invested by the Creator with *imago Dei*—the image of God. There is nothing new, of course, in the idea that this image—the soul of a human—exists, at least in part, in the human capacity to think in abstractions and to communicate in metaphors. However, the suggestion that this capability was granted to humans by God at a specifically identifiable instant in recent evolutionary history is a bit more radical.

For the neuroscientist, the implications of such a suggestion are monumental. If the unique cognitive capability of modern humans exists only because some relatively recent progenitors were touched at a specific point in time by the finger of God, then it is very possible that the (molecular?) mechanisms that give expression to that capability will forever remain beyond the grasp of those investigators who are seeking to understand them.

Of course, there may be an experimentally defensible, physical explanation for the kinetic discontinuity I have described. Yet, when and if such an explanation is offered, it must be able to demonstrate in physical terms how a developmental process that had been in infinitesimally slow progress for billions of years suddenly—in a single tick of the evolutionary clock—endowed one of its products with the capacity to paint the Mona Lisa, to design a moon rocket, to imagine the alpha-helix ... and to perceive God. ★

Suggestions for Further Reading

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Similarities and Differences in Mitochondrial Genomes: Theistic Interpretations

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Often-cited molecular biological arguments for ancestral descent of all living organisms from a single archetypal organism have been based on similarities: similarities in the genetic code, in cellular metabolism, in genome arrangements, and in protein and DNA sequences. In most discussions, dissimilarities or differences receive little attention. Yet, surely differences are as important as similarities in regard to any broad-based theory of organismal relationships.

In this paper, I will examine the similarities and differences of organisms from their mitochondrial DNA (mDNA). I will attempt to evaluate the data from the standpoint of evolution as occurring as a consequence of purely chance events, or as occurring in some manner as a response to a provision of guidance and information by an intelligent cause. Is M. A. Corey correct when he notes "that the process of biological evolution is not only fully consistent with the existence of a Grand Designer, it is also positively unintelligible in the absence of one"?[1] Only in the past twenty to thirty years, have scientists recognized that some cellular organelles, such as chloroplasts and mitochondria in plants and mitochondria in animals, have genetic DNA that is synthesized and used independently of DNA in the cell nucleus. These are independent in the sense that DNA is synthesized in these organelles as the need arises, and that a unique genetic code is often used.

A considerable amount of information is available regarding mDNAs of the simplest eukaryotic organisms (ciliate protozoa, kinetoplastic protozoa, fungi, etc.).[2] These mDNAs are quite variable in structure and in most cases are much more complex (i.e., have larger genomes) than mDNAs of higher animals. The mDNAs of higher plants are also larger and more variable than mDNAs of higher animals.

Although my intention is to restrict the discussion to a consideration of some similar mDNAs found in multicellular animals (metazoa), some comparisons of potential genome size in various cells and organelles is worth noting (see Table 1). By comparison, the nuclear genome of *C. elegans* has ca. 100,000,000 nucleotide pairs. In nearly all metazoan mDNA, we are dealing with a circular DNA molecule and a comparatively small number of nucleotide base pairs (14,000–42,000). Also, a major portion of that DNA is involved in reading frames for either transfer RNA (tRNA), ribosomal RNA (rRNA), or protein sequences. In most cases, the remaining DNA is involved in control of either DNA replication (i.e., making new copies of DNA) or transcription of DNA into RNA sequences. The mDNA of these animals, ranging from sea anemone to humans, is also unique in having very short segments of nucleotide base pairs between genes, or none at all. In a few instances, mDNA genes even overlap by a few base pairs.

Significance of Mitochondria

To discuss mDNA adequately, a brief consideration of mitochondrial function is necessary. Mitochondria are potato-shaped organelles found within cells of eukaryotic organisms (i.e., those with a cell

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nucleus), which have a very specialized function. Although mitochondria contain many different enzymes, they are concerned primarily with production of the energy-rich molecule, adenosine triphosphate (ATP), to supply the energy needs of the cell. This function is carried out by a process known as respiratory chain phosphorylation, by which hydrogens from a substrate molecule are linked in coupled sequential reactions and ultimately combine with oxygen to produce water. The energy produced in this oxidative process is trapped by the mitochondria as ATP for use by the cell.

Most of the genetic information for the production of mitochondrial enzymes comes from the DNA of the cell nucleus. Therefore, most mitochondrial enzymes are synthesized in the cell cytoplasm and transported into the mitochondria where they function. Cytochrome c is an example of this type. In contrast, five other enzyme components of the mitochondrial respiratory chain (NADH dehydrogenase, cytochrome b, cytochrome oxidase, and two ATPases) are coded by mDNA and synthesized within the mitochondria. The mDNA also codes for about 22 different tRNA molecules and two different rRNA molecules. In contrast to nuclear DNA, mDNA is nearly always circular, with the two helical chains referred to as H (heavy) and L (light) chains, respectively.

Gene Size and Genome Arrangement

Table 2 gives an example of gene size and arrangement for protein reading frames and for rRNA genes found in mDNA of higher animals. Note that of thirteen protein coding genes, seven are for a single complex enzyme (NADH dehydrogenase), and three make up the cytochrome oxidase component. In representatives of five different classes (Mammalia, *Mus musculus*, a mouse; Echinodermata, *Paracentrotus lividus*, a sea urchin; Arthropoda, *Drosophila yakuba*, a fruit fly; Nematoda, *Caenorhabditis elegans*, a soil nematode; and Cnidaria, *Metridium senile*, a sea anemone), total reading frames for the thirteen protein genes vary from 3523 to 3963 codons (10,569 to 11,889 nucleotide base pairs), while the reading frames for the individual genes vary in length (mean values) from 61 codons (183 nucleotide base pairs) for the ATPase8 gene to 609 codons (1827 nucleotide base pairs) for the ND5 gene.[3] With these five different class representatives, there is a maximum variability in length for individual genes of 3–39% (mean 18%) for the thirteen protein reading frames. Clearly, some genes have more variability in length than others. This comparison indicates considerable similarity in gene size among organisms as widely separated as a mouse, a sea urchin, a fruit fly, a soil nematode, and a sea anemone. However, it also points out some major differences that must be explained.

Regarding the arrangement of individual genes on strands of circular mDNA, there is considerable variability. In organisms studied thus far, the gene arrangements of four mammals (human, cow, rat, and fin whale) are identical to that of a mouse (see Table 2), a fish (*Cyprinus carpio*, a carp), and an amphibian (*Xenopus laevus*, a toad). When we compare a chicken (*Gallus domesticus*) to a mouse, we find a rearrangement in gene sequence with the displacement of the ND6 and cyt b genes and two tRNA genes. The sequential arrangement of genes in five

Table 1. Sizes of Some Sequenced Genomes

	Nucleotide pairs
Bacteria: *H. influenza*	1,830,121
Mycoplasma	580,070
Plant chloroplast: Liverwort	121,024
Mitochondria[a]	
Mammalia (human, mouse, cow, and fin whale)	16,295–16,569
Amphibia (South African clawed toad)	17,553
Echinodermata (sea urchin, starfish)	15,650–16,200
Arthropoda (fruit fly, honey bee)	16,019–16,343
Nematoda (soil, gut, and root nematodes)	13,794–20,500
Cnidaria (sea anemone)	17,443

[a]For references to these studies, see D. R. Wolstenholme, "Animal Mitochondrial DNA: Structure and Function," *International Review of Cytology* 141 (1992): Table I.

Table 2. Protein and rRNA Genes in mDNA of Mouse

Gene	Length (nucleotides)	
		←
s-rRNA	995	
		←
l-rRNA	1582	
		←
ND-1	945	
		←
ND2	1035	
		←
COI	1542	
		←
COII	681	
		←
ATP8	201	
ATP6	678	
COIII	783	
		←
ND3	342	
		←
ND4L	291	
ND4	1377	
		←
ND5	1821	
ND6	516	
		←
Cyt b	1143	
		←

Genes are listed in sequential order. Arrows indicate positions of one or more of 22 tRNA genes, with 65–75 nucleotides each, which are distributed throughout the circular mDNA. Abbreviations are: s-rRNA and l-rRNA, small and large ribosomal RNAs; ND, NADH dehydrogenase; CO, cytochome oxidase; ATP8 and ATP6, ATPases; and Cyt b, cytochrome b. The numbers and Roman numerals are used to designate the different genes for NADH dehydrogenase and cytochrome oxidase, respectively. There is a ca. 1200 nucleotide control region between the s-rRNA and cyt b genes. Gene size and arrangements are from D. R. Wolstenholme, "Animal Mitochondrial DNA: Structure and Function," *International Review of Cytology* 141 (1992): Fig. 1 and Table II.

other mDNAs are illustrated in Fig. 1 of Wolstenholme.[4] In contrast to the similarities noted above, the genes of two insects (a honey bee, *Apis mellifera*, and a fruit fly, *Drosophila yakuba*) show many gene rearrangements, particularly of tRNA genes. When the gene arrangements of these two insects, a soil nematode, a sea urchin, and a sea anemone are compared to each other or to that of a mouse, scientists find many gene arrangement variations.

Since in any given organism, mDNA is separated into two strands (H and L) during processes of replication and transcription, and since these two strands may each be cut further, several opportunities for rearrangements in the order of genes on a particular strand occur. Among variations in known gene arrangements are those where a particular gene is sometimes found on the H strand of mDNA in one organism and on the L strand in a different organism. Since these two strands proceed in opposite directions, this type of gene arrangement is more difficult to explain than the rearrangement of genes on a single strand. These rearrangements might first appear to be explained by purely chance events. However, recognition signals, which allow strands to recombine in their original sequence arrangement in a particular organism, have not been fully studied. Clearly, cleavage and joining sites must be precise. For a rearrangement, they must be at the beginning or end of genes and not cause alterations (i.e., frameshifts) in triplet codes of genes. As nucleotide sequences in mDNA of more organisms are studied, scientists will discover additional evidence of gene rearrangements in mDNA.

Genetic Code

Although a major argument for ancestral descent has been the universality of the genetic code, in recent years we have learned that the genetic code is not truly universal. This is especially evident when one examines mDNA. The usual genetic code, given in most textbooks, is still valid for nuclear DNA and also for most prokaryotes (i.e., organisms without a cell nucleus). The modifications of the usual genetic code as found in mDNA are shown in Table 3. It will be noted that there have been modifications in five of the sixty-four codons. In a metazoan phylogenetic tree suggested by Wolstenholme, it is proposed that changes in the genetic code have occurred at least eight times.[5]

Although initially, a change in codon usage might appear to be minor, closer examination will reveal extreme difficulties imposed on a cell by a codon change. Two of the more dramatic codon changes

in mRNA are: (1) an AAA coding for asparagine in Echinodermata (e.g., a sea urchin and *Asterina pectinifera*, a starfish) and Platyhelminthes (*Fasciola hepatica*, a liver fluke) instead of an AAA coding for lysine as found in other mDNAs and in nuclear DNAs; (2) a TGA codon indicating tryptophan in all mDNAs, whereas TGA is a stop codon in nuclear DNAs. The first of these codon changes involves a radical change in amino acids since the R-group of asparagine has no charge and that of lysine has a positive charge.

Let us consider in more detail what would be involved in the change of a lysine AAA codon to an asparagine AAA codon. In five different organisms other than echinoderms and platyhelminthes, there are about 80 AAA codons and about 8 AAG codons in mDNA designating lysine.[6] Since replacement of 90% of the lysine codons in protein molecules by asparagine would surely be lethal to the organism, most lysine AAA codons in mDNA would have to change to AAG (or to a codon for another amino acid), since AAG would now be the only codon specifying lysine. Since lysine is such a critical amino acid in most proteins, this codon change from AAA to AAG for most lysine codons must occur in order to produce a functional protein.

Osawa, et al. have proposed a mechanism for this codon change.[7] This proposal requires changes at the level of mDNA (Steps 1 and 4), tRNA (Steps 2 and 3), and proteins (Step 5). Changes at the levels of tRNA and proteins would presumably require changes in DNA, since structural changes in tRNA and proteins are ultimately directed by the information in DNA. Here are the proposed steps.

Step 1. A change of most mDNA codons for lysine from AAA to AAG. This would require 70–80 precise A→G point mutations.

Step 2. A change in the anticodon of $tRNA^{lys}$ from UUU to CUU, with a loss of $tRNA^{lys}$ (CUU) ability to serve in translation of AAA codons of messenger RNA.

Step 3. A change in $tRNA^{asn}$ so that it will translate AAA codons of messenger RNA as asparagine.

Step 4. A change of some asparagine mDNA codons (AAT or AAC) to AAA codons, or of some other selected codons to asparagine codons.

Step 5. Some corresponding changes in protein molecules (e.g., tRNA-aminoacyl synthetases and ribosomal proteins) which interact with aminoacyl tRNAs during the process of translation.

For this proposed mechanism to have significance, each of the first three steps must be completed before the next can begin. In other words, use of the mDNA AAA codon for lysine would have to be totally nonfunctional, before use of an AAA as an asparagine codon could begin. Otherwise, incor-

Table 3. Metazoan Mitochondrial Genetic Code Modifications with Unusual Amino Acid Specifications[a]

Codon	TGA	ATA	AGA	AGG	AAA
Mammalia (5)[b]	Trp[c]	Met	Stop or NF[d]	Stop or NF	Lys
Amphibia (1)	Trp	Met	Stop	NF	Lys
Echinodermata (4)	Trp	Ile	Ser	Ser	Asn
Nematoda (3)	Trp	Met	Ser	Ser	Lys
Platyhelminthes (l)	Trp	Met	Ser	Ser	Asn
Cnidaria (2)	Trp	Ile	Arg	Arg	Lys

[a]In the universal (nuclear) genetic code, these codon representations are: TGA, Stop; ATA, Ile; AGA, Arg; AGG, Arg; and AAA, lys.
[b]Numbers in parenthesis indicate the numbers of species studied; for the species included, see D. R. Wolstenholme, "Animal Mitochondrial DNA: Structure and Function," *International Review of Cytology* 141 (1992): Table IV.
[c]Amino acid abbreviations are: Trp, tryptophan; Met, methionine; Lys, lysine; Ile, isoleucine; Ser, serine; Asn, asparagine; and Arg, arginine.
[d]NF, not found.

rect amino acids would be inserted into protein molecules.

The proposed changes in tRNA (Steps 2 and 3) would involve changes in the anticodon of tRNA, and would likely require changes in other regions of tRNA which selectively bind to ribosomal proteins or enzymes. Since information for these tRNA sequences resides in mDNA, appropriate nucleotide changes (point mutations?) in mDNA would be required to produce tRNA changes. Changes in proteins (Step 5) would require changes in nuclear DNA since genetic information for synthesis of these proteins resides in the nucleus. All changes in Steps 1 through 5 would have to be precisely coordinated in order to produce the one genetic code change of an AAA lysine codon to an AAA asparagine codon.

The change of a TGA codon from a stop codon (as found in prokaryotes and in nuclear DNA) to a mitochondrial tryptophan codon would be nearly as complicated. This codon change in the genetic code is found in all mDNAs with the TGA codon being used for tryptophan about 90% of the time rather than a TGG tryptophan codon. In mDNAs of six quite divergent species, there are about 96 TGA codons for tryptophan and only ten TGG codons (mean values).[8] Even more importantly, in the process of translation, the messenger RNA-ribosome-tRNA complex could no longer recognize the UGA codon in messenger RNA as a stop signal. This surely would also require some structural changes in many different protein molecules involved in mitochondrial protein synthesis. Similar difficulties would be encountered in proposed scenarios for each of the other changes in the genetic code indicated in Table 3.

Implications of mRNA Studies for Theistic Evolution

Explanations for the similarities and differences in mDNA previously cited are varied. The predominant view of most evolutionary biologists today is that only a fully naturalistic explanation can be considered in which all changes are a consequence of purely chance events. In contrast, there are three possible levels of explanation that might be incorporated into an overall design theory of theistic evolution. As Howard Van Till has suggested (Level A): "... every one of these processes and every connective pathway in the possibility space of viable creatures is a mindfully designed provision from a Creator possessing unfathomable intelligence."[9] Therefore, one can consider these events to be guided somehow (providence or governance?) by an intelligent cause, so that changes which would be nearly impossible by chance alone would become reasonable. Or one can consider the deistic evolutionary explanation of M. J. Corey (Level B): "... organisms possess the intrinsic capacity to organize themselves along developmental lines that have largely been pre-determined by information that is either contained within, or is assessed by, the genome."[10] Or one can consider a third level which I have proposed (Level C): "... in the history of the origin and development of living organisms, at various levels of organization, there has been a continuing provision of new genetic information by an intelligent cause."[11] My proposal must be involved in Corey's explanation to account for information in the genome providing the indicated intrinsic capacity. These theistic explanations would *not* deny the considerable role of chance events, but simply would *insist* that one also consider the possible role of a Designer.

Let us examine these different types of changes in mDNA (i.e., size differences, gene arrangements, and genetic code) to see how the above explanations may be applied to the data. The similarities and differences in the size of the mitochondrial protein genes could be given a naturalistic explanation, i.e., they are predominantly a consequence of point mutations, deletions, insertions, etc. However, it is difficult to see where natural selection could play any role as a driving force in these changes, since as far as we know, all of these genes and the proteins they express are fully functional. It seems more likely that a theistic explanation involving governance by the Creator (Level A) would play a role in guiding these size changes. This type of theistic explanation would not appear to be subject to any experimental test. Probability considerations would likely indicate that a theistic explanation would be a more satisfactory explanation than natural selection.

For gene rearrangements, a specific enzyme or ribozyme would be required for DNA cleavage sites and precise recognition of joining ends. The control of the processes of cleavage and of the joining of mDNA genes could very well involve genetic information for involved enzymes or ribozymes. Therefore, theistic levels B and C would have a role in these changes.

For changes in the genetic code, pure chance explanations appear totally inadequate. To suggest that fifty to eighty point mutations of AAA lysine codons would occur fully by chance to form the same number of AAG lysine codons as the required first step in a mDNA codon change is surely impossible based on probability considerations. Also, at present, there is no evidence in organisms of any inter-

mediates for this proposed first step. On the other hand, this type of change could occur if the A→G base changes (point mutations?) were guided by an intelligent designer. With this explanation, changes could occur either rapidly over a short period of time, or more slowly over a longer period without necessarily being lethal to the organism. Since these changes in genetic code are so improbable by chance alone, it may very well be that some innate capacity in the genome (Level B) and some new genetic information (Level C) might be required for these genetic code changes.

For each of the other proposed steps in a codon change (Steps 2 through 5), scientists can provide an explanation based on a series of point mutations in either mDNA or nuclear DNA. However, the coordination of all required steps can only be explained as being under the guidance and control of a supreme intelligence. It seems likely that all three levels of a theistic explanation can be appropriately applied to these changes. Although I have examined, in some detail, the change of a lysine AAA codon to an asparagine AAA codon as an illustration of a change in genetic code, similar problems appear and similar explanations would apply for each of the other codon changes listed in Table 3.

As I noted in an earlier paper, the totally mechanistic theory of evolution assumes a monophyletic origin of life (i.e., all life began with an original archetypal cell).[12] I also noted that a monophyletic origin is a possible component of my design theory of theistic evolution, but it is clearly not mandatory. A polyphyletic origin for living organisms by a common Creator is certainly also a possibility. By now suggesting three possible levels of explanation (Levels A, B, and C) by which a Creator might introduce changes into organisms, I do not wish to infer that there must have been a monophyletic origin of all organisms. Certainly a Designer could supply blocks of new genetic information for separate lineages. Since the design theory of theistic evolution calls for the continuing incorporation of new genetic information, the distinction between monophyletic and polyphyletic origins is not nearly as sharp as it is for a purely mechanistic theory of evolution.

Conclusion

In this paper, I have carefully examined some similarities and differences in a group of fairly similar animal mDNAs and have suggested explanations involving both chance and an intelligent cause. I have not examined other aspects of mDNA, such as nucleotide sequences of both protein and RNA genes, nor have I treated the question of more complex mDNAs in plants or in simple eukaryotic organisms (protozoa, fungi, etc.). Explanations involving chance and an intelligent cause appear appropriate for these unique mDNA features as well. ✯

Notes and References

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[2]D. J. Cummings, "Mitochondrial Genomes of the Ciliate," *International Review of Cytology* 141 (1992): 1–64. The entire volume of this journal is given to papers on mitochondrial DNA. Kinetoplastid mDNA is considered on pp. 65–8 (K. Stuart and J. E. Feigin) and fungi mDNA on pp. 89–127 (G. D. Clark-Walker).

[3]D. R. Wolstenholme, "Animal Mitochondrial DNA: Structure and Function," *International Review of Cytology* 141 (1992): 173–216, Table II. Much factual information on mitochondrial DNA used in this paper is taken from this paper.

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[11]G. C. Mills, "A Theory of Theistic Evolution as an Alternative to the Naturalistic Theory," *Perspectives on Science and Christian Faith* 47 (1995): 112–22; also see _____, "Theistic Evolution: A Design Theory Utilizing Genetic Information," *Christian Scholar's Review* XXIV (1995): 444–58.

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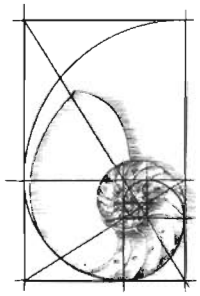

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Video Reviews

RAGING WATERS: Uluru Is a Testimonial to the Flood. Distributed by: American Portrait Films, Inc., P.O. Box 19266, Cleveland, OH 44119-1545. 28 minutes; $19.95.

BIOLOGICAL EVIDENCE OF CREATION: From a Frog to a Prince. Distributed by: American Portrait Films, Inc., P.O. Box 19266, Cleveland, OH 44119-1545. 27 minutes; $19.95.

"Raging Waters" is a somewhat poorly filmed video, produced with the laity in mind. It repeats many of the standard young-earth creationist arguments in support of a global flood. The video makes the following claims: Ayers Rock was deposited recently; folded and tilted strata can only be explained by a global flood; ripple marks indicate a global flood because they need to fossilize rapidly; marine invertebrates found on land must be explained by the flood; fossilized footprints demonstrate that animals were grazing while the floodwaters were rising; because opals can be made rapidly, they were made rapidly in the flood; and fossil hash of marine shells, a whale skeleton, and an opossum in the same deposit can be explained only by a global flood.

These arguments are based on the concept that we do not see anything like this today. Strata, however, can be tilted slowly as is happening in California today. Ripple marks are found in modern sediments. Parts of California are being uplifted at a rate of 25 feet per thousand years, lifting marine animal remains above sea level. Fossil footprints which exist at multiple levels throughout the geologic column are almost conclusive proof that the waters of the supposed global flood could not have been deeper than the length of the animal's legs. As to the whale, opossum, and marine invertebrates found in the same layer, whales today regularly beach themselves and the carcasses of opossums have been observed floating down rivers to the sea. More conventional explanations are quite possible for this occurrence. There is nothing in this video which proves that a global flood occurred.

"Biological Evidence of Creation" is more focused and thus better than the video above. It concentrates its discussion to the supposed inability of mutation to generate new information. After watching the video several times, one realizes that like a mantra, the claim that information cannot be generated by random processes occurs almost continuously. On average such a statement is made every 35 seconds. Other claims made in the video include: the change from a reptile to a bird requires the addition of much information; the avian lung cannot evolve; and all mutations involve a loss of information, not an increase. They further state that the results of any selection process result in the loss of genetic information.

This video presents an obligatory attack on the evolution of the horse. The producers recite the usual claim that horses have not evolved and are merely a created "kind." But this assertion misses the very important fact that if the equids or the canids are each a single "kind," then there has been too much genomic change to fit within their time frame. Horses have 64 chromosomes; Prezwalski's horse, 66; donkeys, 62 or 63; kulans, 55 or 56; and zebras, 44. Among canines, a created "kind," the genomic diversity is equally difficult to explain via young-earth creationism. Dogs, wolves, jackals, and coyotes have 78 chromosomes; foxes, 36 to 66; and South American canids, 74 to 76. Given that these changes in chromosome numbers also involve major alterations in DNA sequences, it seems highly unlikely that this much change could occur in a young universe. This much genetic change means either that the universe is old, or God must have specially created every species, each with its unique chromosomal count and DNA sequence.

One major failing of this video is that there is no discussion of how information is to be measured. The video continually states that information cannot be increased by mutation. Yet polyploidy in plants is a type of mutation which increases the complexity and information content of the genome. Polyploidy contradicts their claim that all mutations represent a loss of information or complexity. Their claim that birds are more complex than reptiles is unsupported by any documentation.

The most controversial moment in the video shows Dawkins apparently stumped by a question concerning the ability of mutation to increase information content of the genome. The video's producer, Gillian Brown, contends that he was stumped. Dawkins says that he was considering throwing them out of his house. Whatever the case, this single moment in the video is going to become an important event for those on both sides of the creation evolution issue.

Nonscientists in the church probably will be unaware of the scientific flaws these two somewhat poorly made videos contain, but likely will be strongly influenced by their presentation.

Reviewed by Glenn R. Morton, geophysicist, 16075 Longvista Dr., Dallas, TX 75248.

BEFORE THE BEGINNING: Our Universe and Others by Martin Rees. Reading, MA: Addison-Wesley, 1997. 291 pages. Hardcover; $25.00.

Rees is a Royal Society Professor and Great Britain's Astronomer Royal. Educated at Cambridge University and based there for most of his career, Rees has traveled extensively and is a member of several foreign academies. He is a leading researcher on cosmic evolution, black holes, and galaxies. While in his doctoral program, he would open and hold books for Stephen Hawking to read as Hawking's paralysis progressed. In the Foreward to this book, Hawking writes:

> While I have been primarily interested in developing the theory and much of my work has not yet been confirmed by observation, Martin has always worked closely with the observations and what they tell us about the universe. This book brings the reader in contact with the real stuff of astronomy without mentioning the word God that Martin seems so uneasy with.

While this book is written from an agnostic or atheistic worldview (I'm not quite sure which), it represents the work and insights of a recognized expert in the field of cosmology. Although it is not easy or particularly interesting to read, I consider it essential reading for the layperson in science who wants to know what is happening in the field of cosmology. The first half of the book was tough going for me, partly because each chapter is broken up into numerous topics, many of which seemed to be unrelated. I was experiencing the problem of too many trees to see the forest. I am happy to say that after about 140 pages everything began falling into place and I began to see the big picture. (This, no doubt, is due to my lack of knowledge of cosmology and not Rees' organization.) Perhaps the best way to provide an overview of the book is to simply list a few of the 15 chapter titles: "From Atoms to Life: Galactic Ecology," "The Cosmic Scene: Expanding Horizons," "Pregalactic History: The Clinching Evidence," "Black Holes: Gateways to New Physics," and "Toward Infinity: The Far Future, Coincidences and the Ecology of the Universe."

Rees asks many questions throughout the book and states he has no answers for some of them, e.g., "Why is there a universe at all?" or "Why should the universe expand so uniformly and symmetrically?" Rees struggles with the question: "Why are the basic physical constants so fine-tuned?" Examples of these constants include the strengths of fundamental forces, the masses of elementary particles, and the ratio of photons to baryons. To avoid the concept of a creator or intelligent designer, Rees prefers the idea of a multiverse which would encompass all possible universes and all possible values of fundamental constants. Rees writes:

> Nothing, perhaps, could seem to violate Ockham's razor more drastically than postulating an infinite array of universes. Nor does it, at first sight, seem properly scientific to invoke regions that are unobservable, and perhaps always will be. But the concept helps to explain basic (and previously mysterious) features of our universe, such as why it is so big, and why it is expanding.

Rees' writing is not without humor at times. For example, he quotes Lev Landau: "Cosmologists are often in error but seldom in doubt." And from Roger Penrose: "Inflation is a fashion the high-energy physicists have visited on the cosmologists; even aardvarks think that their offspring are beautiful."

Although I found the book difficult to read, it was worth the effort. This book is not written for the popular audience, as is Hawking's *A Brief History of Time*, but it is far more satisfying to read. I was particularly interested in Rees' struggles to explain the creation of the universe without acknowledging the Creator.

Reviewed by Bernard J. Piersma, Chemistry Department, Houghton College, Houghton, NY 14744.

TIME'S ARROW AND ARCHIMEDES' POINT by Huw Price. New York: Oxford University Press, 1996. 306 pages. Paperback; $14.95.

The mathematical formulation of the microscopic laws of physics are invariant under time reversal and yet many of the processes of nature seem to be asymmetric in time. This book is a profound attempt to study these puzzles of the direction of time from a new viewpoint "outside" time, or from Archimedes' Point meaning "a view from nowhere." Price claims that it is common for both physicists and philosophers to fall prey to an anthropocentric subjectivity of interpreting and regarding the world in terms of human experiences.

Price, a philosopher, has been bouncing his ideas off physicists and philosophers for over ten years and has become very good at presenting, in lay language, philo-

sophical arguments to physicists and physics concepts to philosophers.

The first part of the book concentrates on the Second Law of Thermodynamics and the historical struggle of Boltzmann and others to understand the source of the Second Law's time asymmetry. Price points out persistent mistakes or hidden assumptions which physicists often make when they think about the direction of time. For example, Boltzmann can prove the Second Law by assuming that two particles are uncorrelated before they collide but correlated (i.e., know each other) after they collide. This assumption violates the time symmetry and elegance of the basic laws of physics and is a questionable assumption without any direct empirical justification.

Next, Price looks at electromagnetic radiation in terms of the Wheeler-Feynman absorption theory. Keeping the same mathematical formalism of outgoing ("retarded") and incoming ("advanced") solutions of the wave equation, Price reinterprets some key concepts in this theory. He argues that radiation processes are inherently time symmetric and that any asymmetry results from boundary conditions.

Price contends that all processes at the microphysics level are probably time symmetric and that all of the asymmetries at the macrophysics level result from the boundary condition of Big Bang cosmology. The early state of our universe as studied in the cosmic background radiation is known to be very smooth and structureless. With the gravitational force as the dominant influence on our universe, this beginning is a very improbable (low entropy) state. All of the time asymmetries at the macrophysics level, e.g., thermodynamics and radiation, result from the universe evolving into statistically more probable states, or higher entropy.

The middle section of Price's book, in which he examines causality, is mostly philosophical. Specifically, if state A evolves into state B, what justification do we have stating that A can cause B, but B cannot cause A? He considers the case of an astronaut on a star sending a photon through a polarizer to Earth. Another person, on Earth, detects the photon after passing it through another polarizer. Why can we conclude that the polarization of the photon during its multiyear journey is determined solely by the polarizer on the star and not by the polarizer on the Earth?

There is no empirical test to verify our causality assumption. Humans certainly have a temporal asymmetry. We deliberate and act for the future and consider the knowable past to be unchangeable. But what about the inaccessible past, i.e., the polarization of the photon? Price argues for "advanced action" in microphysics where future events can affect the inaccessible past. He argues against those who might disparage this hypothesis as nonempirical or metaphysical by justifying it on factors such as simplicity and symmetry. Even more so, he justifies advanced action as leading to an interpretation of quantum mechanics which preserves the principles of locality, unlike the Copenhagen interpretation.

The last third of the book deals with the philosophical interpretation of quantum mechanics and the confrontation of Einstein's realism with the Copenhagen interpretation. In the Copenhagen interpretation, reality depends upon the observer's choice of measurement. Price examines the EPR paradox in which two particles are moving in opposite directions away from an entanglement. The Copenhagen interpretation says the measurement of momentum or position of one particle gives reality to the momentum or position of both particles. However, if the momentum of one particle and the position of the other are measured, then conflicting realities result. Since the time-ordering of the measurements depends on the inertial frame, different reference frames give different realities. This is the nonlocality problem which is caused by the effects of a measurement propagating instantaneously across space.

As an alternative to the Copenhagen interpretation, John Bell, in considering a hidden variable theory, proved that it also must be nonlocal unless the hidden variables of one particle are correlated with the choice of measurement of the other particle. He rejected such correlation as a violation of free will of the person making the measurement. Price points out that locality can be restored and free will maintained if the choice of measurement of one particle has "advanced action" on the hidden variables of the other particle.

Price omits theology in his book, but his advanced action raises many theological questions. Is the inaccessible past also inaccessible to God? Does God act in the future to affect the present? Is our free will constrained somewhat by our future as well as our past? This profound book opens up possibilities for further study.

Reviewed by William Wharton, Physics Department, Wheaton College, Wheaton, IL 60187.

KINSHIP TO MASTERY: Biophilia in Human Evolution and Development by Stephen R. Kellert. Washington, DC: Island Press, 1997. 240 pages, notes, index. Hardcover; $25.00.

Kellert is a professor at the Yale School of Forestry and Environmental Studies. Among his other books are: *The Value of Life: Biological Diversity and Human Society* (1996) and *The Biophilia Hypothesis* (1993) which he coedited with Edward O. Wilson. *Kinship to Mastery* continues the exploration of the concept of biophilia introduced by E. O. Wilson in his landmark book, *Biophilia* (1984). Kellert is considered a leading authority on the multifaceted relationship which exists between humans and the natural world.

In the first chapter of the book, Kellert defines biophilia as the deep and enduring human desire to connect with living diversity. A biologically-based attraction for nature reflects the human tendency to impute value and importance to the natural world. This inherent inclination to affiliate with nature and living diversity represents a col-

lection of relatively weak biological tendencies that depend on adequate learning and experience. Without repeated experience and social support, the various strands of biophilia remain dormant and unfulfilled. Kellert argues that our physical, intellectual, emotional, and spiritual well-being are dependent upon the maintenance of rich and healthy connections with natural diversity. As he points out, opportunities to interact with natural diversity are becoming more difficult in many parts of the world because of the recent wave of biological destruction and environmental degradation that has accompanied economic development and technological advancement. Kellert believes that a healthy and diverse natural environment is an essential condition for a satisfying and fulfilling life. The overarching goal of the book is to convince the reader that the preservation of natural diversity represents more than an act of human kindness. It is, in his words, a profound expression of our own self-interest and ultimately, a celebration of our humanity.

Chapters two through ten explore aspects of the extraordinary variability and intricacy of the human response to natural diversity. The first aspect visited is the material basis for biophilia which recognizes nature's provision of food, medicine, clothing, and other products. The third chapter presents the aesthetic appeal of nature. Like all expressions of biophilia, the aesthetic response is shaped and nurtured by learning and experience. One adaptive benefit of the aesthetic response focuses on the ways in which natural surroundings can promote physical healing and mental restoration. In chapter four, the intellectual benefits provided by contact with the natural world are highlighted. Kellert suggests that increased knowledge of nature will lead to a deeper awareness and appreciation of nature's inherent value. The next chapter, "Nature as Metaphor," considers the natural world as a source of communication and thought, providing humans with opportunities for language acquisition, psychosocial development, and symbolic imagery. Chapter six presents nature as a source for exploration and discovery. Through intimate contact with nature, our physical fitness can be enhanced, our curiosity expanded, and our self-confidence increased. A more emotional aspect of biophilia, which stresses the desire for kinship with other creatures, is discussed in chapter seven. This is followed by a chapter on the competitive aspect of biophilia which involves the urge to master and subdue nature. In chapter nine, religious aspects of biophilia are surveyed, including a brief summary of the different ways in which Judeo-Christian traditions have understood humankind's relationship to the natural world. Chapter ten concludes Kellert's overview of the various expressions of biophilia with a discussion of what could be described as biophobia: the ways in which the natural world can be a powerful source of human fear and anxiety.

In the last two chapters, Kellert highlights the ways in which modern society has compromised and diminished our need for connecting with nature and living diversity. He also discusses the problems of habitat destruction, the introduction of non-native organisms and diseases, and the excessive exploitation of natural resources, all of which are responsible for the precipitous decline in worldwide biological diversity. He outlines three strategies for dealing with this problem. The first strategy emphasizes the protection and restoration of biologically rich and diverse natural systems. His second strategy focuses upon the need to break the vicious cycle of disaffection and alienation from nature which persists in many of our cities today. Last, but not least, Kellert stresses the need for education and the importance of ethics in order to arrest the current decline in biodiversity.

Kellert presents the various aspects of biophilia in a clear, concise, and organized manner. It is his hope that this book will be as meaningful for the layperson as it is for the scientist. In my opinion, this hope has been fulfilled. Interspersed throughout are fictional vignettes which he uses to illustrate the role of natural diversity in human development. These vignettes serve the purpose of connecting the concept of biophilia to real-life situations, making the book all the more interesting for the general public. Biologists and other scientists will benefit not only from the book's content, but also from the notes provided. Many of these notes refer to Kellert's previous books and to E. O. Wilson's publications, which suggests that this book is offering previously published material in a nonscientific manner to reach a wider audience.

The book ends with an extended vignette about a family living in New York City that is on the verge of disintegration. An extended vacation on an island off the coast of Nova Scotia not only saves this family from self-destruction, but also serves as the beginning of a series of lifelong interactions with the natural world. This vignette illustrates Kellert's main thesis, that connecting with nature is the key to our physical, intellectual, emotional, and spiritual well-being. The Scriptures also teach the importance of maintaining a proper relationship with creation. However, Scripture emphasizes two other types of relationships—our relationship with God and our relationships with our fellow human beings. A true sense of well-being can only be enjoyed if all three of these relationships are nurtured and properly maintained!

Reviewed by J. David Holland, Biology Instructor, Springfield College in Illinois, Springfield, IL 62702.

PHILOSOPHY OF BIOLOGY by Michael Ruse, ed. 2d ed. Amherst, NY: Prometheus Books, 1998. 370 pages, notes. Paperback; $18.95.

Ruse, the founding editor of the journal *Biology and Philosophy*, has long been involved in scholarship in the philosophy of biology. The first edition of *Philosophy of Biology* was published in 1989. Given the advances in biological sciences since then and the new philosophical issues emerging as a result, this second edition incorporates several new essays, such as those of Arthur Peacocke, Philip Hefner, and Ronald Lindsay. These more recent essays are organized under new topics which have assumed a central place in current philosophical debates arising out of advances made in biological sciences. For instance, the essays of Hefner and Lindsay address the

issues related to the topic of human cloning. At the same time, this edition has retained the "classical" pieces which address the more fundamental philosophical questions, such as the essays by Aristotle, Darwin, and Huxley.

The essays are organized under sections, which, in turn, are presented in an order that maintains a certain degree of continuity between the sections. The sections represent a progression from fundamental (age-old) questions, such as "What is life?" to more contemporary issues such as the matter of human cloning. At the same time, they also represent a progression from the purely philosophical issues such as matters of design and teleology to more ethical or moral issues related to human behavior. Between the Introduction at the beginning and a Bibliographic Essay at the end (both written by Ruse), there are thirty-seven essays organized under thirteen sections. The sections represent the following topics in the order of their appearance in the book: Life, Design, Darwinism, Classification, Teleology, Molecular Biology, Genetic Engineering, Sociobiology, Extraterrestrial Life, Evolution, Ethics, God and Biology, and Human Cloning.

The essays selected for each topic collectively address the fundamental biological concepts or principles involved, the nature of the philosophical or ethical issues arising from these concepts, and the ways in which the principles themselves can be used to address the issues. For instance, under the topic of teleology, there are three essays. The first one by Williams provides a commentary on the concepts of biological adaptation and natural selection. Then Kramer argues that the problem regarding the question of teleology arises as a result of the misuse of the term "strategy" in relationship to biological adaptation and natural selection. Finally, Ayala clarifies the nature of teleological explanations of biological phenomena using Webster's definition of the term "teleology" (*Webster's Third New International Dictionary*, 1966).

Ayala points out two forms of teleological explanations: (1) Natural (or internal) teleology—teleological features attributable to some natural phenomenon, and (2) Artificial (or external) teleology—teleological features attributable to purposeful action consciously carried out by an agent. He further distinguishes natural teleology into determinate (or necessary) and indeterminate (or nonspecific). Determinate teleology is represented by phenomena which lead to a specific end-state (such as homeostasis) or features which serve specific functions (such as wings of birds). Indeterminate teleology refers to events for which the end-state served is not specifically predetermined, but rather results from the selection of one from several available alternatives. Thus, biological adaptations (such as wings) represent determinate teleology, whereas the availability itself of specific genetic alternatives upon which natural selection could act (to lead to the formation of wings) represents indeterminate teleology. Ayala's purpose in all this is to illustrate the role teleological explanations can play in describing evolutionary phenomena, rather than address the issue of whether teleological explanations point to divine creative activity. To be sure, such is the case in all sections of the book, namely that the issues are treated from within the perspective of "natural" biology and do not address any questions related to "supernatural" involvement. An exception to this observation is the second to last section titled "God and Biology" in which the specific issue of divine creation as presented in the Bible versus Darwinian evolution is addressed.

In the Introduction, Ruse provides a summary of each section highlighting the nature of questions addressed and the way they are dealt with by the authors in each section. At the end of the book, Ruse provides a "Bibliographic Essay," which cites several important works the reader can go to for further exploring the issues addressed in various sections of the book. The bibliographic essay is superior to the usual bibliography at the end of the book in two ways. First, it contains Ruse's comments regarding the nature and significance of the works cited so that the reader can see why these might be important for further study. Second, the paragraphs in this essay pertain to literature on specific themes, areas, or topics so that the reader can focus more easily on literature related to particular topics rather than search through an alphabetized list of references.

Philosophy of Biology presents a quick access to literature important to both biology and philosophy students. It is a useful reference resource for scholarship in biology as well as philosophy and can also serve as text for philosophy courses focusing on biological sciences.

Reviewed by Pradeep M. Dass, Assistant Professor of Biology and Science Education, Northeastern Illinois University, 5500 N. St. Louis Ave., Chicago, IL 60625-4699.

THE HUMANIZING BRAIN: Where Religion and Neuroscience Meet by James B. Ashbrook and Carol Rausch Albright. Cleveland, OH: The Pilgrim Press, 1997. 272 pages, index. Paperback; $20.95.

Ashbrook and Albright "regard the [human] brain as a primary lens with which to study and understand the cosmos and its dynamic source, namely, God" (p. 163). They do not believe that the human brain was brought into existence *ex nihilo*, but rather accept the main scientific view that "the structures and functions of the brain seem to track the eons of evolution that gave rise to it." (This sentence appears on p. 132 *and* on p. 146.)

The human brain contains three regions: (1) an inner, lower "reptilian" brain inherited from ancient lizards and snakes; (2) a mid-cap "mammalian" brain inherited from early viviparous animals; and (3) the upper, frontal, uniquely primate cortex.

The "reptilian" region produces the basic traits of self-preservation, self-propagation, and the establishment and defense of territory.

The "mammalian" region is the seat of human emotions, empathy, and memory. Senior author Ashbrook, professor emeritus of religion and personality at Garrett-Evangelical Theological Seminary, has written several

books and articles on the connection between these matters and God. This book is a treasure trove of insights into how our minds work: "We humans have the old brain-mind in common with other vertebrates. It connects us with nature itself and, in faith, with God" (p. 97).

With what kind of God do the authors connect? Not a miracle-worker. "God does not 'pull strings'" (p. 149). God is often referred to as the Ground of Being. The authors liberally and approvingly quote the process philosophers Whitehead, Cobb, and Griffin. And from Hartshorne we have "the social structure is the ultimate structure of all existence" (p. 87).

Concerning the human cortex and forebrain, the following is typical:

> [the left and right halves of the human cerebral cortex] are analogues of the two main characteristics of God in that the step-by-step analytic process of the interpreting (left) hemisphere can be discerned in God's redeeming power of straightening life up, and the all-at-once, holistic process of the integrating (right) hemisphere can be seen in the radiant goodness throughout all of God's creation (p. 111).

Will theologians ever get their physics right in print? We read: "Einstein ... has shown us ... matter may be transformed into energy, energy becomes matter, and for some purposes the two may be seen as one and the same" (p. 139). But not for the purposes of this book! $E = mc^2$ is relevant in the million- or billion-electron-volt energy range, whereas the brain operates at energies of a few electron volts. Einstein did not turn physics into mush.

The assertion that "those working on the forefront of science ... no longer believe" in "strict predictability and causality" (p. 154) does not apply to those who have studied the time-dependent Schrödinger equation, which describes how one quantum state is transformed into another in a nice causal fashion.

The reader also should take the technical information on neurobiology with caution. The glossary contains this definition: "CENTRAL NERVOUS SYSTEM: those parts of the brain and spinal chord that respond to conscious or deliberate intentions" (p. 192). Actually, the central nervous system incorporates *all* of the brain and spinal cord; it involves unconscious and reflexive signals.

One wishes that coauthor Albright, executive editor of *Zygon: Journal of Religion and Science*, had limited this book to fields of science with which the authors were more authoritatively acquainted, or had engaged a consultant. If you pick up this book in a bookstore, I suggest that you first peruse Chapters 3–7, which address the various functions of the brain and their theological significance. In the first two introductory chapters, some readers might find pearls of deep wisdom leaping from every page; other readers might find a flood of abstract generalizations. Beginning on p. 51, the writing becomes less abstract and easier to follow.

Reviewed by Lee A. Young, 144 Chestnut Circle, Lincoln, MA 01773.

TRANSFORMING HUMAN CULTURE: Social Evolution and the Planetary Crisis by Jay Early. Albany, NY: State University of New York Press, 1997. 359 and xiii pages, bibliography, index. Paperback; $19.95.

This book is a volume in the SUNY series in constructive postmodern thought. Early, a psychotherapist, has doctoral degrees in psychology and computer science. He wrote this book because he thinks we are facing an ecological disaster which evolving man can solve. This environmental crisis is only a symptom of a much broader social crisis. However, we now have an opportunity to create a healthy global society, a new level of evolution. The present situation is a natural outgrowth of social evolution which the author sketches from about 35,000 BC. He shows what he thinks is progress made at each stage of evolution.

The treatment is superficial, which is to be expected in a book of this size which covers social developments stretching over about 400 *centuries*. The author acknowledges that his academic background is in psychology, but the theory he is presenting "deals with social, political, and economic issues; with technology and ecology; with science and religion" (p. 7). Christianity and its influence are barely mentioned, and where they are mentioned, it is only in a general way. The fact that this book gives an idea where postmodern thinking is headed might be of interest to some people. Near the end of the book, Early writes: "We could rely on our cognitive understanding of ecological reality to motivate us to care for our environment, but if we also identify with earth as a whole using our emotional and spiritual capacities, we are more likely to succeed."

Reviewed by Jan de Koning, 20 Crispin Crescent, Willowdale, ON, Canada M2R 2V7.

GENETIC ETHICS: Do the Ends Justify the Genes? by John F. Kilner, Rebecca D. Pentz, and Frank E. Young, eds. Grand Rapids, MI: Eerdmans Publishing Company, 1997. xii and 291 pages, glossary of genetic terms, index. Paperback; $22.00.

When investigating new theories or using new methods, we often concentrate only on our own particular area of expertise. Even when asking the question, "What will the result be if we do this?" we usually think of our own discipline, and rarely about other disciplines. Still, many theories have ethical implications where we do not expect them. For example, the discovery of the inner workings of atoms eventually resulted in the atom-bomb. A biologist working in a laboratory studying genes wonders what will happen if he does a certain experiment. He may never think of the larger political and ethical consequences of his work.

After the preface by the editors, three writers introduce the subjects to be treated about recent developments in genetics under the general heading, "The Experience of Genetic Challenges." Are experiments in cloning ethically neutral? Should ethical and religious limits be placed on

experiments? After the Introduction follows Part I, "Genetic Perspective;" Part II, "Genetic Information;" and Part III, "Genetic Intervention." The writers are from many disciplines: biology, ethics, biblical religion, medicine, genetics, philosophy, law, education, politics, nursing, technology, politics, and theology. Some essays are easy to read, with others outside our own specialty may cause trouble.

All chapters have information which we should know before passing judgment on problems in these areas. For example, the same or similar techniques that may be used for cloning can be used to repair certain diseases. Should we teach these techniques, and if so, for what purpose?

This book shows once again that nobody can act in his own area as if it were an independent area of study. Beautiful results in one discipline may cause disastrous results in other disciplines. These Christian authors come from several different denominations, seminaries, colleges, and other institutions. They may not all agree with solutions others propose, but all agree that it is necessary to talk together about the problems caused by new findings in genetics. I recommend this book for study and as an example of Christians working together.

Reviewed by Jan de Koning, 20 Crispin Crescent, Willowdale, ON, Canada M2R 2V7.

WRONGNESS, WISDOM, AND WILDERNESS: Toward a Libertarian Theory of Ethics and the Environment by Tal Scriven. Albany, NY: State University of New York Press, 1997. 218 pages (including 18 pages of notes, bibliography, and index). Paperback; $20.95.

Scriven is professor of philosophy at California Polytechnic State University in San Luis Obispo. In this book, he demonstrates his facility in using ideas from some of the major voices in philosophy and ethics, including Plato, Hume, Rousseau, Kant, Schopenhauer, and Nietzsche. He self-references two papers, one titled "Utility, Autonomy And Drug Regulation" published in the *International Journal of Applied Philosophy*, and the other titled "Plato's Democratic Man and the Implausibility of Preference Utilitarianism" published in *Theory and Decision*.

This book has three parts titled "Wrongness," "Wisdom," and "Wilderness." Part I discusses the historical and theoretical perspectives of utilitarianism (with special emphasis on the writing of J. S. Mill), social ethics, and individual ethics. In these seven chapters, Scriven concludes that utilitarianism fails as a social theory because pleasure and goodness, or the well-being of individuals, is not an adequate basis for social decisions. The meaning of pleasure or goodness has received no consensus. He suggests that a better basis is the concept of harm, since the idea that pain is bad finds general agreement. Pain, claims Scriven, is the only thing that is universally held to be intrinsically evil. Further, "there are certain types of activity that can have such damaging consequences to a person's moral and psychological well-being that the activity ought to be considered harmful." But the prohibition of certain types of actions should be very limited and the burden of proof must rest with the state. Utilitarianism is not a mechanism for guaranteeing rights but for restraining government.

Part II (five chapters) outlines theories of individual ethics or morality, which is what Scriven means by the term wisdom. He strongly advocates the idea that "social morality and individual wisdom are about different things; social morality should concern itself with the prevention of harm; individual wisdom should concern itself with the pursuit of good." Our behavior as individuals should not be dictated by the demands of social morality. "There is a limited range of activity that the state or community can make a legitimate claim to be able to control on the basis of its wrongness. Of the rest of life, not only does the community have no right to control the lives of individuals, it has no right to even proclaim them as wrong." Scriven maintains that government has no business addressing moral behavior in the private sphere. In the private sphere, "the individual need have no justification or even explanation for what he or she does." The range of social morality, where there is a genuine fact of the matter about right and wrong, stops at the private sphere. He then discusses how one ought to live one's life, regardless of how others behave.

Part III is a discussion of how Parts I and II relate to nature. His argument suggests that ecocentrism should be rejected because either it is "incoherent or not in sync with the best available accounts of how nature really works." Scriven finds it more than coincidence that environmental concerns emerge in times of increasing exploitation of natural resources. He discusses the writings of Callicott, Garret Hardin, Cheney, and Eckersley, among other ecocentrists, ecofeminists, and postmodernists. According to Scriven, postmodernism cannot be criticized since any critique is "just so much more Western, patriarchal, sexist, racist, capitalist, Cartesian, linear, hierarchical, hegemonic, colonizing, totalizing asceticism."

I did not find this book particularly easy reading, but it does present a very interesting perspective on how to look at the environment and environmentalism. At times, the author strays rather far (in my opinion) from his central thesis, but he does try to tell us in each chapter where he intends to go. I find much in the book to think about and some things to agree with, e.g., "in the dark age of academic postmodernism, it is only threat, idle rhetoric, harassment, and embarrassment that count." I also find things with which I strongly disagree, e.g., "I am not even committed to the view that humans, per se, are intrinsically valuable." On abortion Scriven says, "the burden of proof would seem to fall squarely on the shoulders of the antiabortionists, it is up to them to prove that the fetus is the sort of thing that can be harmed. It is not up to the proabortionist to prove that abortion is harmless ... the issue should be settled in favor of the proabortionist." What does all this have to do with the environment? Read the book and find out.

Reviewed by Bernard J. Piersma, Chemistry Department, Houghton College, Houghton, NY 14744.

HEALING A WOUNDED WORLD: Economics, Ecology, and Health for a Sustainable Life by Joseph Wayne Smith, Graham Lyons, and Gary Sauer-Thompson. Westport, CT: Praeger Publishers, 1997. 209 and xviii pages, bibliography, index. Hardcover; $65.00.

In the 1990s the environmental debate is about such things as human biomass appropriation, declining biodiversity, global warming, and the rupture of the Earth's ozone shield. The authors want to show how the world is hurtling toward anarchy and social chaos due to overusing economic goods. They divide the users of economic goods into two categories: *limitationists*, those who believe that we are fast approaching the limits of growth; and *economists*, those who believe that there are no such limits. Economists believe that neoclassical economics, utilitarianism, the rational-economic-man model of human behavior, and the free trade theory are true and adequate. The authors of this book are limitationists. They attack the idea that economics is the most basic science for understanding human society because it is a reductionist approach, related to reductionist approaches in other sciences.

In the first two chapters, "A Wounded World: Can Civilization Be Sustained?" and "Global Meltdown: Population Growth and Environmental Destruction," they state their case: There are limits to population growth. They mention R. L. Sassone who quotes Gen. 1:28: "subdue the earth" and says that there is no limit to growth (p. 33). Since the Bible says "subdue" not "destroy," the authors reject that argument. Not all societies in history considered "progress" a social construction. In 2050, the world will face an incredible problem dealing with ten billion people. More people will mean more pollution. Quoting Harrison, they show that the rich are greater polluters than the poor, thus causing more pollution. This in turn causes increased global heating, higher sea levels, and more rain. Rich countries can defend themselves against this by dikes and other means. Poorer countries probably cannot, causing migrations which are not welcome in rich countries.

Chapter three, "The Unreasonable Silence of the World: Postmodernity and the Crisis of Philosophy, Science and Knowledge," discusses the downfall of the Enlightenment, and thus the lack of an all-encompassing philosophy of knowledge. Even in the natural sciences, no unity of vision exists. Reason is often impotent in the political sphere, especially regarding environmental issues. But politicians avoid tough issues, or worse, choose the course not leading to environmental sustainability.

Chapter four is titled "Economic Irrationalism: Against Cosmopolitan Economics." The writers are afraid of the problems an unrestricted global economy will bring: the breakdown of national economies and more free trade. As unskilled workers become plentiful, their incomes in developed countries will go down. That will be especially dangerous for the United States, where economic stratification of society is greater than anywhere else, the writers claim. In 1996 the rate of child poverty in the United States was four times higher than in other developed nations. The poor are worse off in absolute terms than twenty years ago. According to the Grace Commission Report, in the year 2000 the accumulated US government debt will be 13 trillion dollars, or nine times the amount collected in income taxes (pp. 104, 105). The authors hope to stimulate the development of an ecologically responsible economic theory in which nature is not taken as a limitless pollution sink.

Despite the hopeful title of chapter five, "Endgame: Healing a Wounded World," they conclude:

> The conclusion of our study is unfortunately a negative one: the basic minimum conditions for a healthy, ecologically sustainable life for all people on Earth cannot be met. Sadly, the technological and economic optimists are wrong. We are entering a new dark age; an age of the great dieback in the exuberant growth of the human species.

The authors are Australians. Smith is Senior Research Fellow in Geography at the University of Adelaide; Lyons is a leading businessman, cattle rancher, and environmentalist; Sauer-Thompson is a lecturer in philosophy at the Flinders University of South Australia. In North America, we have the tendency to look at the world from a strictly American point of view. In this book, we see how others view the world. I recommend this book to everyone for study and possible action. Even if you do not agree with everything, the book shows areas where action needs to be taken.

Reviewed by Jan de Koning, 20 Crispin Crescent, Willowdale, ON, Canada M2R 2V7.

AN INTRODUCTION TO BIOETHICS by Thomas A. Shannon. Mahwah, NJ: Paulist Press, 1997. 189 pages. Paperback; $14.95.

This book is an excellent guide for discussing ethical problems caused by using biological materials. Shannon is a professor of religion and social ethics in the Department of Humanities and Arts at Worcester Polytechnic Institute.

Shannon mentions five essential dimensions of technology: function, energy, fabrication, communication, and control. A technology assessment should also examine the impact of technical rationality on personal and professional relationships and society. Technology is a way of thinking which leads to compartmentilization, a distrust or diminishment of subjectivity and a preference for instruments and objectivity. Technology makes it necessary to reconceptulize and re-imagine humans and their social relationships. Those observations are foundational to the book and the way the book is organized.

At the end of each of the sixteen chapters are discussion questions, notes and a bibliography. This makes it easy to use the book as a textbook and as a discussion guide for church and other groups. The book has four parts: "General Issues," "Birth Technologies," "Death and Dying," and "Specific Problems." In the last part the writer introduces questions related to genetic engineering, organ

transplantation, research on human subjects, patients' rights, and whole earth ethics.

Reviewed by Jan de Koning, 20 Crispin Crescent, Willowdale, ON, Canada M2R 2V7.

ENVIRONMENTAL STEWARDSHIP: Images From Popular Culture by Dorothy J. Howell. Westport, CT: Bergin & Garvey, 1997. 280 pages, index. Hardcover; $59.95.

Stewardship is a distinctly Christian term used by the church to advocate a biblical ethic of sharing (mostly money) and caring for God's creation. The term is adopted by the title of this book but, unfortunately, its historical biblical meaning is diluted by other (hi)stories recounted in the author's search for a contemporary environmental ethic.

Howell, formerly an applied microbial ecologist, environmental counsellor and educator, is a Ph.D. candidate in Environmental Studies at Antioch New England Graduate School. She claims "an active vocation in Christian theology with a firm foundation in the teachings and foundations of the Old Testament" (p. xviii). However, the book does not delve deeply into this foundation. Her brief writings about biblical stewardship are accepting of the Judeo-Christian view, but only as one narrative among many.

A premise of this book is that everyone is searching for an environmental ethic, but no one individual, discipline, or culture enjoys a monopoly over the concept of stewardship. This search arises from western culture's estrangement from nature. Options for reconnection are explored through an array of ideas (Greek philosophy, Gaia, biophilia, Jungian psychology, Thomas Berry's "dream of the earth"), religions (Islam, Buddhism, Hinduism, Taoism), and stories from primal cultures (African, Australian, Polynesian). Particular attention is given to worldviews of First Nations peoples (Amerindians), especially their relationship to the land.

Alienation from nature in western culture is characterized by ambivalence about our sense of place. We oscillate between bringing civilization to nature (resource exploitation, industrialization, urbanization) and bringing nature to civilization (urban parks, home gardens). This ambivalence is reflected in images of popular culture, the book's subtitle. The continuous search for a renewed human/nature relationship is manifested in popular mythical characters that portray the pastoral Puritan, wilderness man, or noble savage. The book examines at length our fascination with feral individuals in fiction (*Tarzan* series by Edgar Rice Burroughs), cinema (*Planet of the Apes*), and television (Spock in *Star Trek*). These popular images symbolize our search for reconnecting with nature and our place in it.

Howell recognizes that a relationship with nature is as much spiritual as it is ecological. An important source of insight here is the integration of science and theology. She even gives a glowing tribute to the American Scientific Affiliation and this journal for being in the forefront of this integration (p. 212).

In exploring the spiritual dimension of a new environmental ethic, biblical tenets are briefly summarized. These include the Abrahamic covenant, Fall of creation, Christ's incarnation, and redemption of all creation. However, the theological conclusion is not a call for redeemed relationships among Creator, humans (stewards), and creation but rather biocentrism: "... humans are ontologically one with nature" and "... the relationship between humans and ... creation must proceed from that fact" (p. 217).

This book has eighteen chapters organized into five parts. It generally progresses from broad philosophical musings about the origin of alienation from nature in western culture to specific expressions of this alienation in images of popular culture to a call for reconnecting with the natural world via personal environmental ethics and national environmental policy.

Much of the text consists of quotations from other sources that are strung together with concurring commentary. Except for the reflections on popular culture (four chapters on Tarzan and his contemporaries), there is not much new. Sadly for the Christian, insights based on a biblical understanding of stewardship do not accompany the co-opted title.

Reviewed by Harry Spaling, Director of Environmental Studies, The King's University College, Edmonton, Canada.

HUMAN NATURE AT THE MILLENNIUM: Reflections on the Integration of Psychology and Christianity by Malcolm A. Jeeves. Grand Rapids, MI: Baker Books, 1997. 249 pages, index. Paperback; $19.99.

Jeeves is honorary research professor at the University of St. Andrews School of Psychology in Scotland and well-known author of several books tracing interactions between psychology and Christian faith. He wrote this book especially with Christian psychology students in mind. It has thirteen chapters focusing on such central topics as neuropsychology; human nature; consciousness; and determinism, freedom, and responsibility. As an aid to the reader, Jeeves has added a section, "Taking Stock," at the end of each chapter to put specific emphasis where it is needed in as straightforward a way as possible.

The focus of the book is "primarily on basic sensory and cognitive processes and their biological substrates; on the part played by psychological, neural, and genetic factors in determining behavior; and on issues arising from such research for Christian beliefs." For most areas of psychology his position is clearly stated: "Any attempt to mix Christian beliefs with psychological accounts is guaranteed to cause confusion and to make nonsense of both." Jeeves does not mean that Christian beliefs and psychological accounts should be put into noninteracting compartments. He means that we should not expect a psychological theory of development to be different be-

tween Christians and non-Christians. Also we should not develop a theory that incorporates Christian beliefs with empirical evidence.

Next the author considers the role of neuropsychology in linking mind and brain ever more closely together, which raises the question of how this picture can be related to a biblical, Hebrew-Christian view of humankind. He stresses the importance of parallel descriptions on different levels: "Explaining what is happening at one level is not the same as explaining away the phenomenon under investigation." Consideration is given to such historically adopted options as dualism, epiphenomenalism, and psychophysiological parallelism, choosing for his view Mackay's comprehensive realism. "The irreducible duality of human nature is, on this view, seen as duality of aspects rather than duality of substance." This discussion then leads naturally to considering the role of neuropsychology and spiritual experience, with examples of the tight link among neural processes, psychological states, and spiritual awareness. "The point is simple: With neural changes there are psychological consequences and these, in turn, affect spiritual awareness."

In the fifth chapter, Jeeves turns to a consideration of the link between the brain and human behavior, choosing homosexuality and aggressive behavior as two relevant areas. He argues that our personal characteristics are not *determined* by our genes, but what our genes do is *predispose* us to certain characteristics and behaviors, which can nevertheless be altered by changing environmental conditions. He concludes:

> The general pattern of evidence from studies in the field of neurogenetics and behavior is to alert us to the pressures that tend to shape our behavior. Above all, it should sensitize us to the power of such influences and, in so doing, should induce a greater compassion toward those who may be struggling.

The author next considers specific biblical and psychological representations of "human nature," inquiring as to the salient features of a biblical view of human nature. He faces the issue that the "kinds of questions posed by twentieth-century scientists were not even framed by the biblical authors, let alone answered by them." He finds in the subject of "human nature" the interplay of different complementary accounts, with a "stark contrast between the ways in which theologians write about human nature and the vocabulary, concepts, and theories of scientific psychologists," primarily because the purposes of the two are quite different. The author defends the view that "Man is a psychophysical or somatopsychic unity," a statement with meaning both in this present earthly life and in some new form in the new heavens and new earth.

The seventh chapter raises the question of whether there are meaningful differences between human and animal nature. The author concludes that distinctive differences between humans and animals will not be found in physical and mental differences, but in the realization that humankind has the unique capacity for a personal relationship with our Creator.

Jeeves next considers the subject of "personology," those parts of psychology which deal with theories of personality and the theory and practice of psychotherapy. Such theories "are especially vulnerable to the intrusion of the personal beliefs and values of the theorists." He believes that it is not appropriate to incorporate Christian beliefs in personology. "Rather, Christian beliefs should motivate research and practice in psychotherapy, and Christian values should inform the compassionate practice of psychotherapy. But above all, the Christian commitment is to 'telling the story as it is' and this must remain paramount in an area of psychology where personal values can so readily intrude."

The following chapter continues this theme in developing attitudes toward human needs from psychological and theological perspectives, and reviews the views of five of this century's most influential personality theorists: Freud, Erikson, Maslow, Rogers, and Fromm. This is followed by a look at four theological traditions: Augustine, Aquinas, Jonathan Edwards, and Karl Rahner. Again the complementary aspects of the two approaches are most important.

Chapter 10 considers the subject of "consciousness," giving several detailed examples of the developing scientific debate. While appreciating the mysterious nature of consciousness and the enormous task involved in understanding it scientifically, still this "does not constitute an excuse (or even a reason) for going on to assert 'so far science cannot explain consciousness so this is where God is to be seen at work.' To follow that route would be to resurrect the God-of-the-gaps approach." Although no easy answers are available from the scientific study of consciousness, there is a strong warning against two of the suggested solutions of the past: dualism and eliminative monism. At the end of the chapter, Jeeves raises an "emergent properties" perspective in suggesting:

> Could it be that the same material "stuff," brains, of animals as well as humans, due to changes in structural complexity, at some point undergo something analogous to "a phase change" so that new properties of mind, consciousness, and a capacity for spiritual awareness emerge in humans?

In the following chapter, he considers the perspectives of four Nobel Prize winning biologists: Francis Crick (materialist reductionist), Sir John Eccles (dualism of mind and body), Gerald Edelman (neural Darwinism), and Roger Sperry (dynamic emerging property of brain activity). A comparison of the views expressed is a warning "against any simplistic solutions to the problems we face," but it appears that a dualist view of mind and brain must give way to the ontological priority of mental life.

In Chapter 12, Jeeves tackles the persistent problems associated with the concepts of determinism, freedom, and responsibility. He emphasizes a needed distinction between methodological determinism (an approach that presupposes the possibility of orderly description), empirical determinism (the assumption that descriptions without exceptions are possible), and metaphysical determinism (an ontological worldview in which all human psychological events follow universal laws). Increasing

evidence for a link between mind and brain has led to the question of whether human beings do have genuine freedom of choice. The author concludes a description of proposed possibilities with the call:

> Let us at least hold fast to our basic personal experience of choice and responsibility without denying the neurological insight that our mental activity is incarnated in our brains. These are complementary aspects of the whole person, just as wave and particle are complementary aspects of light.

The ideological reductionist claim that our experience of freedom of choice is an illusion must be seen as "blatantly unscientific special pleading." The concept of "freedom" also has at least two possible interpretations: the liberty of spontaneity (a compatibilist view) and the liberty of indifference (a libertarian view). He argues that the liberty of spontaneity can be more readily reconciled with God's sovereignty, than the liberty of indifference. After comparing the positions of Polkinghorne, Peacocke, and Mackay, the author casts his vote to the liberty of spontaneity and the logical indeterminacy view of Mackay, on the grounds that "it seems to do most justice to the theological teaching about God's general providential care of all things at all times."

The book concludes with a final chapter that is an excellent and perceptive summary of the various points of debate discussed earlier in the book.

This is an excellent book, with carefully developed distinctions and positions. It is a prime example of outstanding work of a Christian in the field of psychology. The significant nuances are so great that the writing of a book review of ordinary length becomes almost impossible.

Reviewed by Richard H. Bube, Emeritus Professor of Materials Science and Electrical Engineering, Stanford University, Stanford, CA 94305.

THE HOLY LAND: An Oxford Archaeological Guide from Earliest Times to 1700 by Jerome Murphy-O'Connor, ed. New York: Oxford University Press, 1998. 489 pages. Paperback; $18.95.

This book will appeal to anyone interested in Holy Land archaeological sites. For its moderate price, the reader receives extensive word descriptions of Holy Land locations significant to its three major religions and cultures. In addition, the reader is provided with 150 site plans, maps, diagrams, and photographs. The alphabetical listings plus a comprehensive index make it easy to locate topics of particular interest. It is touted as "by far the best popular guide to its subject ever written." This book does not venture beyond AD 1700 because nothing created after that date is classified as an antiquity.

This book will provide pleasures for the curious, nostalgic, and religiously motivated. Even the nontraveler may find value in the brief historical outline which introduces the volume. About a third of the space is devoted to the city of Jerusalem, while the remainder is a guide to the land. The editor not only provides information but also makes editorial judgments about it. For instance, of Gordon's Garden Tomb, he says: "there is no possibility that it is in fact the place where Christ was buried." On the other hand, of the Church of the Holy Sepulchre he writes: "Is this the place where Christ died and was buried? Very probably, yes." Sometimes biblical sites may be discussed under a less familiar name, i.e., Latrun for Emmaus.

This revised and expanded fourth edition provides coverage of all the main sites in Jerusalem (including routes through the Old City) and throughout the country. To help the visitor prioritize, sites are rated, museum times provided, and desert areas described. Practical advice is offered on travel and lodging, appropriate dress, and export of artifacts. Jerome Murphy-O'Connor, a New Testament professor in Jerusalem, is author of *Paul: A Critical Life*. Other guides published by Oxford University Press in this series include those on Rome, Scotland, and Spain. Christians who find their faith strengthened by having it firmly rooted in history and archaeology will find this book an inspiration.

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

NEW AMERICAN COMMENTARY (GENESIS 1–11) by Kenneth A. Mathews. Nashville, TN: Broadman and Holman Publishers, 1996. 528 pages, index. Hardcover; $34.99.

Mathews is professor of Old Testament at Beeson Divinity School, Samford University. He is an acknowledged expert in the Dead Sea scrolls, text criticism, biblical Hebrew, and the literary study of the Old Testament, having written or edited books and articles in these areas.

His commentary on Genesis 1–11 thoroughly covers foundational doctrines. The freewill of man (pp. 211–2), the explanation of evil (pp. 226–31), and the divine model for marriage (pp. 222–5) are all dealt with in detail. Moreover, Mathews puts special emphasis on explaining what it means to be made in the image of God (pp. 164–75). Later he concludes that "human life must be treated with special caution because it is of singular value as life created in the image of God" (p. 402).

Mathews convincingly argues that the biblical flood was worldwide according to the Bible (pp. 365, 380) and that it was not based on other ancient pagan flood myths (pp. 86–100). He explains that these epics differed from the biblical flood story (pp. 339–40) and that the biblical flood story has no chronological inconsistencies (pp. 377, 385, 492).

The issues of creationism and naturalism are covered (pp. 101–7). Mathews points out that "philosophical naturalism denies the existence of God, while methodological naturalism, though not explicitly rejecting deity, excludes God in developing a theory of the universal process" (p. 102). He shows that creationists have their different views too, but the disagreement is "not about who? but about how? and how long? and when?" (pp. 106–7). Mathews

cites the works of J. P. Moreland, Phillip Johnson, K. P. Wise, Henry Morris, John Whitcomb, Hugh Ross, H. J. Van Till, Bernard Ramm, W. L. Bradley, and C. B. Thaxton.

Mathews spends a good deal of time discussing the documentary hypothesis and the historical-critical approach that many modern scholars use when examining the pentateuchal witness (pp. 63–85, 353–6, 377, 435–6). Mathews disagrees with the critical approach, and he gives some evidence that seems to nullify the liberal view that the Pentateuch was written during the first millennium B.C. The literary evidence indicates a much earlier date of authorship. Mathews observes:

> Several lines of internal evidence, while unable to prove traditional Mosaic authorship, indicate the concurrence of a second millennium date, such as the antiquity of Deuteronomy's literary structure having similarity to international treaty formulas of the Late Bronze Age (p. 79).

Mathews is not alone in this view. He cites the works of other scholars such as M. G. Kline, P. C. Craigie, E. Merrill, P. J. Wiseman, D. J. Wiseman, G. C. Aalders, G. Archer, R. K. Harrison, K. A. Kitchen, O. T. Allis, E. J. Young, I. Abrahams, M. H. Segal, and B. Jacob (p. 79). Furthermore, Mathews notes:

> The names of the coalition of kings in Genesis 14 and the political circumstances accord well with what we know of this early period. The author was an eyewitness of the events in Exodus–Deuteronomy and was well acquainted with Egyptian language and geography. Egyptian loanwords from the second millennium are found in Hebrew (p. 79).

Obviously Mathews has extensive knowledge of ancient Near Eastern languages, literature, and culture. The New American Commentary series is one of the finest on the market today, and Mathews continues the scholarly tradition with his work on the first eleven chapters of Genesis. I highly recommend it to the readers of *PSCF*.

Reviewed by Everette Hatcher III, P.O. Box 23416, Little Rock, AR 72221.

Letters

A Comment on Barclay's Strategy

In the short paper by Oliver Barclay ("A Strategy for the Evolution Debate," *PSCF* 50, no. 3, [1998]: 161–3), there is much counsel with which I would agree. However, in his suggested proper strategy, he states in item 2 that we should "... move from the largely negative and defensive approach ('You cannot explain this!') to a much more aggressive attack on the philosophy of naturalism." I find the first portion of this statement by Barclay to contrast with a statement by Richard Swinburne (Ibid., 220):

> Scientists, historians, and detectives observe data and proceed thence to some theory about what best explains the occurrence of these data. We can analyze the criteria which they use in reaching a conclusion that a certain theory is better supported by the data than a different theory—that is, is more likely, on the basis of those data, to be true. Using those same criteria, we find that the view that there is a God explains *everything* we observe, not just some narrow range of data.

I find myself agreeing with Swinburne, that our job as scientists is to *critically examine* the data which support or fail to support a theory. I consider this to be a positive rather than a negative approach. If this means that we have to say: "Your theory cannot explain this!" then we should point this out. In doing so, however, I think we should be careful to stay within our own area of expertise. I continue to believe some type of design theory of theistic evolution explains much that a theory based totally on chance events can never explain.

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Update and Corrections to Pun's Article

After speaking with Dr. Francis Collins at the ASA/CiS conference, August 1998, I want to add the following addendum to my paper, "Toward an Ethics of the Human Genome Project" published in September 1998: 164–75.

According to Dr. Francis Collins, director of the National Human Genome Research Center, the Genetics Confidentiality and Discrimination Act of 1996 and 1997 was withdrawn by its original proponent Senator Domenici. It was well intentioned but the technical wordings may be interpreted to restrict scientific research on the Human Genome Project.

Please note the following errata:

1. The headers at the top of pages 165, 167, 169, 171, 173 and 175 should read: "Toward an Ethics of the Human Genome Project" not "Toward an Ethics of a Humane Genome Project."
2. On p. 165, in my biography section, 3rd line: "... his M.A. in Theology" not "... his M.S. in Theology."
3. On p. 171 paragraph on the top right column: all the references to Colossians should be Chapter 1, not 3, i.e., Col. 1:15–16, 2nd line; Col. 1:17, 9th line; Col. 1:19, 10th line.
4. On p. 174, in reference 33, 2nd line: "105th Congress on March 11, 1997" not "on March 11, 1998."

Pattle Pun
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Index, Volumes 48–50, 1996–1998

The locations of indices for previous volumes are listed on the inside back cover of the journal. Numbers in each entry refer to volume, issue, page number, month, and year. For example, 48:2, 73, J 1996 refer to volume 48, issue number 2, page 73, June 1996. The names of the book reviewers are listed in parentheses after each book review.

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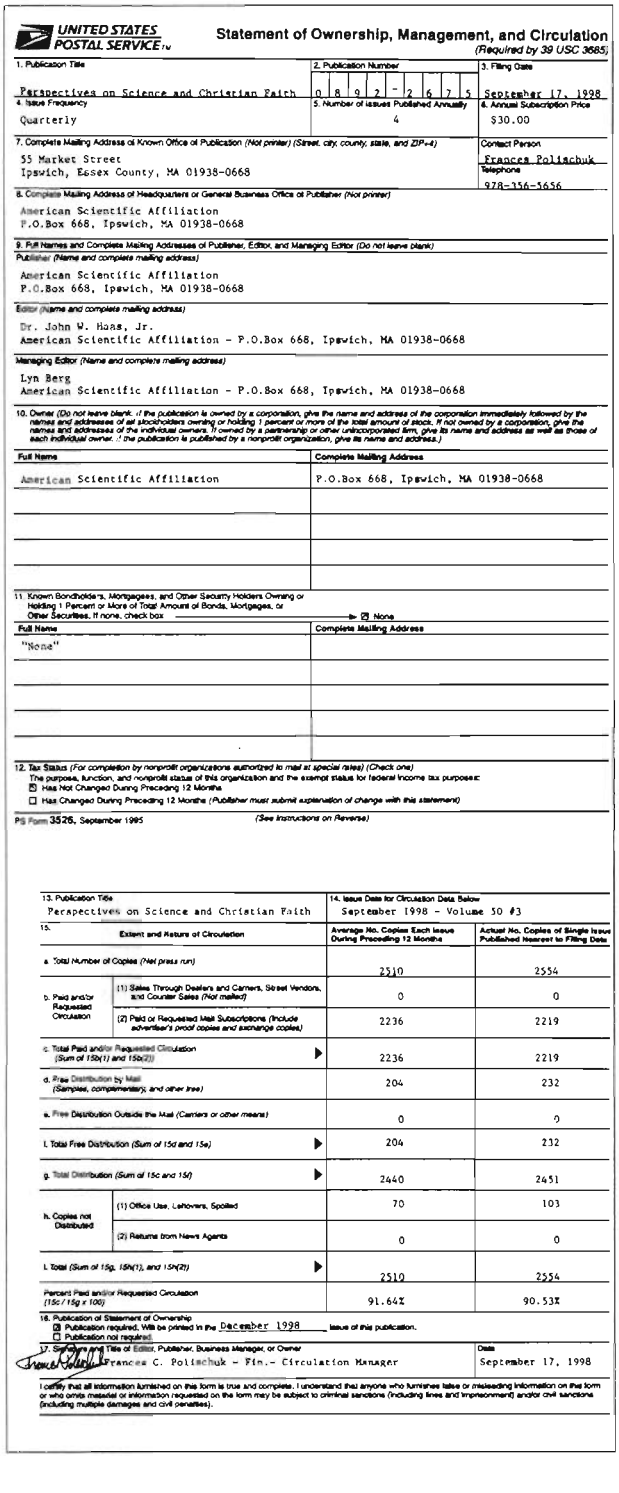

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☐ Has Changed During Preceding 12 Months *(Publisher must submit explanation of change with this statement)*

PS Form 3526, September 1995 *(See Instructions on Reverse)*

13. Publication Title: Perspectives on Science and Christian Faith	14. Issue Date for Circulation Data Below: September 1998 - Volume 50 #3	
15. Extent and Nature of Circulation	Average No. Copies Each Issue During Preceding 12 Months	Actual No. Copies of Single Issue Published Nearest to Filing Date
a. Total Number of Copies *(Net press run)*	2510	2554
b. Paid and/or Requested Circulation (1) Sales Through Dealers and Carriers, Street Vendors, and Counter Sales *(Not mailed)*	0	0
b. Paid and/or Requested Circulation (2) Paid or Requested Mail Subscriptions *(Include advertiser's proof copies and exchange copies)*	2236	2219
c. Total Paid and/or Requested Circulation *(Sum of 15b(1) and 15b(2))* ▶	2236	2219
d. Free Distribution by Mail *(Samples, complimentary, and other free)*	204	232
e. Free Distribution Outside the Mail *(Carriers or other means)*	0	0
f. Total Free Distribution *(Sum of 15d and 15e)* ▶	204	232
g. Total Distribution *(Sum of 15c and 15f)* ▶	2440	2451
h. Copies not Distributed (1) Office Use, Leftovers, Spoiled	70	103
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16. Publication of Statement of Ownership
☑ Publication required. Will be printed in the December 1998 issue of this publication.
☐ Publication not required.

17. Signature and Title of Editor, Publisher, Business Manager, or Owner: Frances C. Politchuk - Fin.- Circulation Manager — Date: September 17, 1998

I certify that all information furnished on this form is true and complete. I understand that anyone who furnishes false or misleading information on this form or who omits material or information requested on the form may be subject to criminal sanctions (including fines and imprisonment) and/or civil sanctions (including multiple damages and civil penalties).

HOW DO I JOIN THE ASA?

Anyone interested in the objectives of the Affiliation may have a part in the ASA.

Full, voting membership is open to all persons with at least a bachelor's degree in science who can give assent to our statement of faith. Science is interpreted broadly to include anthropology, archeology, economics, engineering, history, mathematics, medicine, psychology, and sociology as well as the generally recognized science disciplines. Philosophers and theologians who are interested in science are very welcome.

Associate membership is available to interested nonscientists who can give assent to our statement of faith. Associates receive all member benefits and publications and take part in all the affairs of the ASA except voting and holding office.

Full-time students may join as Student Members (science majors) with voting privileges or as Student Associates (non-science majors) with no voting privileges. Spouses, who also wish to join, qualify for a redued rate. Full-time overseas missionaries are entitled to complimentary Associate membership in the ASA.

An individual wishing to participate in the ASA without joining as a member or giving assent to our statement of faith, may become a Friend of the ASA. Friends receive all member benefits and publications and take part in all the affairs of the ASA except voting and holding office.

Membership Categories and Rates

Category	Rate
Full Member	$55
Friend of the ASA	$55
Associate Member	$55
Student Member	$20
Student Associate	$20
Spouse	$10

Subscriptions to our journal, *Perspectives on Science & Christian Faith,* are available at $30/year (individuals), $45/year (institutions) and $20/year (students). The journal comes automatically with your membership.

MEMBERSHIP/FRIEND OF ASA APPLICATION/SUBSCRIPTION FORM

(Subscribers complete items 1 & 2 only)

American Scientific Affiliation, P.O. Box 668, Ipswich, MA 01938-0668

1. Name (please print) _____ Date _____

2. Home address _____

_____ Zip _____

Office address _____

_____ Zip _____

Please leave blank any numbers you do not wish published.

Home phone _____ Office phone _____

Fax _____ e-mail _____

I would prefer ASA mailings sent to: ❑ home ❑ office

3. Sex _____

4. If married, spouse's name _____

5. Academic Preparation

Institution Degree Year Major

_____

_____

_____

_____

Major field of study _____

Area of concentration within the field (2 word limit) _____

Briefly describe what your present or expected vocation is _____

_____

_____

_____

Please complete back of this form ☞

AS A MEMBER YOU RECEIVE:

Publications. As a member, you receive ASA's quarterly journal, *Perspectives on Science & Christian Faith,* and bimonthly Newsletter. The journal has become the outstanding forum for discussion of key issues at the interface of science and Christian thought. It also contains news of current trends in science and reviews of important books on science/faith issues. The Newsletter brings you news of the scientific work and Christian witness of ASA members, reports of ASA activities, and other items of current interest. It also carries notices of ASA members seeking employment and of positions open to Christians trained in science.

Books. ASA titles such as *Teaching Science in a Climate of Controversy* and the *Membership Directory* are sent to all new members when available. Other books and resources are sometimes available for purchase through the home office. We now offer the books, *God Did It, But How?* by Robert B. Fischer that suggests we separate Who? and Why? from What? and How? and *Being A Christian in Science* by Walter R. Hearn that looks at what scientists do and addresses the hard questions Christians face as scientists. We also offer the leaflet, *God and the Big Bang* by Michael Poole

Fellowship. The spiritual and intellectual stimulation of ASA meetings is a distinctive feature of ASA membership highly valued by those who participate. An Annual Meeting, which usually includes three days of symposia, papers, field trips, and worship together, is held each year (since 1946) in late July or early August. For the convenience of members, the location moves across the country on a regular cycle. Local and regional meetings are held throughout the country each year. Members keep in contact with each other through the Newsletter, Internet, and at ASA get-togethers at national scientific meetings.

Church Affiliation _____

How did you learn about the ASA? _____

If you are an active overseas missionary, please give the name and address of your mission board or organization to qualify for complimentary membership.

Name _____

Street _____

City _____ State _____ Zip _____

I am interested in the goals of the American Scientific Affiliation. Upon the basis of the data herewith submitted and my signature affixed to the ASA Statement below, please process my application for membership.

Statement of Faith

I hereby subscribe to the Doctrinal Statement as required by the ASA Constitution:

1. We accept the divine inspiration, trustworthiness and authority of the Bible in matters of faith and conduct.
2. We confess the Triune God affirmed in the Nicene and Apostle's creeds which we accept as brief, faithful statements of Christian doctrine based upon Scripture.
3. We believe that in creating and preserving the universe God has endowed it with contingent order and intelligibility, the basis of scientific investigation.
4. We recognize our responsibility, as stewards of God's creation, to use science and technology for the good of humanity and the whole world.

Signature _____ Date _____
(required for Member, Associate Member, Student member status)

I have enclosed (Please check one):

____ $55, Full Member ____ $55, Friend of the ASA ____ $55, Associate Member

____ $20, Student Member ____ $20, Student Associate ____ $10, Spouse

Credit Card #: _____ (MasterCard or VISA only)

Expiration Date: _____ Signature: _____

Please mail to: American Scientific Affiliation, P.O. Box 668, Ipswich, MA 01938-0668

Opportunities for Service. The ASA sponsors and encourages individual and group efforts to serve both the Christian community and the scientific community. Major efforts are made to clear up misunderstandings of one group by the other, but speaking and writing are not the only forms of ASA ministry. We seek opportunities to witness as a body of people with a grasp of biblical truth wherever that witness is needed.

Affiliations and Commissions. Each member is asked to choose a primary and secondary affiliation or commission from the list below. Affiliations are autonomous but usually meet in conjunction with the ASA Annual Meeting. Commissions help plan Annual Meetings, report to the membership through the Newsletter, and have a chair with four to five other members as a steering committee. Each of the commissions is asked to relate its discipline toward science.

a. Affiliations

Affiliation of Christian Biologists
Affiliation of Christian Geologists

b. Commissions

Bioethics	Industrial
Communications	Philosophy and
Creation	Theology
Global Resources	Physical Sciences
and Environment	Science Education
History of Science	Social Sciences

The ASA is a member of The Evangelical Council for Financial Accountability.

WHAT EXACTLY IS THE AMERICAN SCIENTIFIC AFFILIATION?

The American Scientific Affiliation (ASA) is a fellowship of men and women of science and disciplines that can relate to science who share a common fidelity to the Word of God and a commitment to integrity in the practice of science. ASA was founded in 1941 and has grown significantly since that time. The stated purposes of the ASA are "to investigate any area relating Christian faith and science" and "to make known the results of such investigations for comment and criticism by the Christian community and by the scientific community."

Science has brought about enormous changes in our world. Christians have often reacted as though science threatened the very foundations of Christian faith. ASA's unique mission is to integrate, communicate, and facilitate properly researched science and biblical theology in service to the Church and the scientific community. ASA members have confidence that such integration is not only possible but necessary to an adequate understanding of God and his creation. Our total allegiance is to our Creator. We acknowledge our debt to him for the whole natural order and for the development of science as a way of knowing that order in detail. We also acknowledge our debt to him for the Scriptures, which give us "the wisdom that leads to salvation through faith in Jesus Christ." We believe that honest and open study of God's dual revelation, in nature and in the Bible, must eventually lead to understanding of its inherent harmony.

The ASA is also committed to the equally important task of providing advice and direction to the Church and society in how best to use the results of science and technology while preserving the integrity of God's creation. It is the only American evangelical organization where scientists, social scientists, philosophers, and theologians can interact together and help shape Christian views of science. The vision of the ASA is to have science and theology interacting and affecting one another in a positive light.

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The American Scientific Affiliation

Founded in 1941 out of a concern for the relationship between science and Christian faith, the American Scientific Affiliation is an association of men and women who have made a personal commitment of themselves and their lives to Jesus Christ as Lord and Savior, and who have made a personal commitment of themselves and their lives to a scientific description of the world. The purpose of the Affiliation is to explore any and every area relating Christian faith and science. *Perspectives* is one of the means by which the results of such exploration are made known for the benefit and criticism of the Christian community and of the scientific community.

Canadian Scientific & Christian Affiliation

A closely affiliated organization, the Canadian Scientific and Christian Affiliation, was formed in 1973 with a distinctively Canadian orientation. The CSCA and the ASA share publications (*Perspectives on Science and Christian Faith* and the *ASA/CSCA Newsletter*). The CSCA subscribes to the same statement of faith as the ASA, and has the same general structure; however, it has its own governing body with a separate annual meeting in Canada.

Local Sections

of the ASA and the CSCA have been organized to hold meetings and provide an interchange of ideas at the regional level. Membership application forms, publications, and other information may be obtained by writing to: American Scientific Affiliation, P.O. Box 668, Ipswich, MA 01938-0668, USA or Canadian Scientific & Christian Affiliation, P.O. Box 386, Fergus, ON N1M 3E2, CANADA or by contacting the CSCA website at: http://avatar.uwaterloo.ca/~mann/cscahome.htlm

Chicago–Wheaton	D.C.–Baltimore	Guelph, ON	Los Angeles	New York–New Jersey
Rocky Mountain	San Diego	San Francisco Bay	Southwest (AZ)	Toronto, ON

INDICES to back issues of *Perspectives* are published as follows:

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Vol. 16–19	(1964–1967)	*Journal ASA*	19	126–128	(1967)
Vol. 20–22	(1968–1970)	*Journal ASA*	22	157–160	(1970)
Vol. 23–25	(1971–1973)	*Journal ASA*	25	173–176	(1973)
Vol. 26–28	(1974–1976)	*Journal ASA*	28	189–192	(1976)
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A keyword-based on-line **subject index** is available on 5 1/4" or 3 1/2" computer disks for most IBM compatible computers with a hard disk or two floppy disk drives. It includes all software and instructions, and can be ordered from the ASA Ipswich office for $20.

Articles appearing in *Perspectives on Science and Christian Faith* are abstracted and indexed in the CHRISTIAN PERIODICAL INDEX; RELIGION INDEX ONE: PERIODICALS; RELIGIOUS & THEOLOGICAL ABSTRACTS, and GUIDE TO SOCIAL SCIENCE AND RELIGION IN PERIODICAL LITERATURE. Book Reviews are indexed in INDEX TO BOOK REVIEWS IN RELIGION. Present and past issues of *Perspectives* are available in microfilm form at a nominal cost. For information write: University Microfilm Inc., 300 North Zeeb Rd., Ann Arbor, MI 48106.

"Upholding the Universe by His Word of Power" — Hebrews 1:3

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