PERSPECTIVES on Science and Christian Faith

JOURNAL OF THE AMERICAN SCIENTIFIC AFFILIATION

In this issue . . .

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

VOLUME 52, NUMBER 3 SEPTEMBER 2000

Perspectives on Science and Christian Faith

MANUSCRIPT GUIDELINES

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

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

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

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YOUNG SCIENTIST CORNER contains varied autobiography submissions as well as notices of special interest to science undergraduate and graduate students and young science professionals who are entering the workforce. Submissions by students (an e-mail attachment of the text is preferred) are encouraged and are typically published within 6 months.

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

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

The View from Shepherd's Knoll

A Gift Shared

My wife, Elva, is my best commentator, critic, and champion of my editorial work on *Perspectives on Science and Christian Faith*. Her creative ideas not only enhance her skills as a practicing optometrist, but also influence her view on life. Her insights into submitted manuscripts and published articles provide a needed perspective for this editor. In honor of her, I am using my editorial space to share with you a poetic essay that she wrote months ago. *

Roman J. Miller, Editor
millerrj@rica.net

The Cradle

God carefully, intentionally, lovingly prepares the soil. Scientists say the method is billions of years in process—energy is formed into electrons, protons, neutrons; these specks are formed into globs; these globs are pressured into elements; these elements bathed in water—and the soil is formed.

Then watch! God causes this soil to produce life. Plants and trees spring up, almost defying their cradle of life by raising their leaves high above the soil. Then come the crawling animals. They too are formed from the soil. They are free and yet not free from their cradle of life. They are free to roam above the soil, yet they are sustained by eating plants of the soil. Eventually, however, an unseen umbilical cord pulls them all back to the soil in death.

Then look carefully—a new creation! This one too is formed from soil, the cradle of life. In this creation, however, the umbilical cord is broken. Adam's race is to transcend its cradle of life. This race is to be free from the soil's hold. This race is free to choose, to rule, and to live forever. We stand in silence watching—Adam's race images the Creator!

In This Issue

The Human Genome Project and other advances in genetics are hot issues in current science news. Two authors, James Peterson and Hessel Bouma, contribute their insights on the significance of the genetic revolution that we are experiencing. Catherine Crouch in the Young Scientist Corner reflects on the ethics of embryonic stem cell research.

The lead article by Gary Emberger in the Regular Paper section deals with the thorny issue of death versus creation. Can a good omnipotent God include death as part of a good creation? Does the presence of animal death before human sin negate the atonement of Christ? While you may not agree with all of Gary's analysis or with his answers to these questions, his insights and ideas are worthy of further reflection. Ronald Larson, using RNA viruses as a model, challenges Darwinism as the simple naturalistic explanation of origins. While Ronald's paper appears technical at points, his arguments are understandable even if you have never had a course in virology or molecular biology. Picking up on Richard Dawkins' promotion of Darwinism as a climb up a "gently

But, alas! Adam chooses to defy the Creator. Our picture of God is marred; we can no longer see God clearly. We stand aghast. The cradle of life becomes the cradle of death for each and every member of Adam's race. Each one falls to the soil and is consumed by it. The land is defiled by that which it was never to receive—the land receives the blood of Adam's race.

The land reels under this blood. The land reels under the misguided rule of the wayward race. It calls out to its Creator with groanings that cannot be uttered—and waits for the liberation and glorious freedom of the children of God as they are released once more from the soil forever.

Dr. Elva B. Miller
Harrisonburg, VA

sloping meadow," Ronald characterizes the terrain to be more rugged and less simplistic than Dawkins imagines.

In the Communications section, four authors are featured. Ben Carter takes issue with Richard Dawkins' uses of metaphors by giving Dawkins a below average grade in poetry. Charles Austerberry provides some helpful guidelines for science educators as they talk about evolution in the classroom. George Murphy suggests that God is revealed most clearly not in the miracles of creation but in the cross of Christ and proceeds to relate a cross apologetic to scientific issues. David Siemens analyzes various understandings of origins from recent creationism through various evolutionary approaches and reasons to select the one view that "best" accounts for the existence of our world.

Fifteen book reviews in various categories comprise our book review section in this issue. We conclude this issue with six letters from readers who continue the dialogue on previously printed material in *PSCF*.

Jocund reading,

RJM

Call for Papers

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

Renewal: A major focus is the physical ecological environment including renewable resources, stewardship, etc. Appropriate inclusions are articles on renewal in other modalities such as living organisms, cellular systems, and psychological or theological realms. Deadline for manuscripts: December 1, 2000.

Ethics: How shall we live and work? Articles may include such things as medicine, health, environment, professional behavior, education, philosophical foundations, etc. Deadline for manuscripts: June 1, 2001.

All submitted manuscripts should deal with the interaction between science and Christian faith in a manner consistent with scientific and theological integrity. Submitted articles will be peer reviewed. Send manuscripts to:

Roman J. Miller, Editor
Perspectives on Science and Christian Faith
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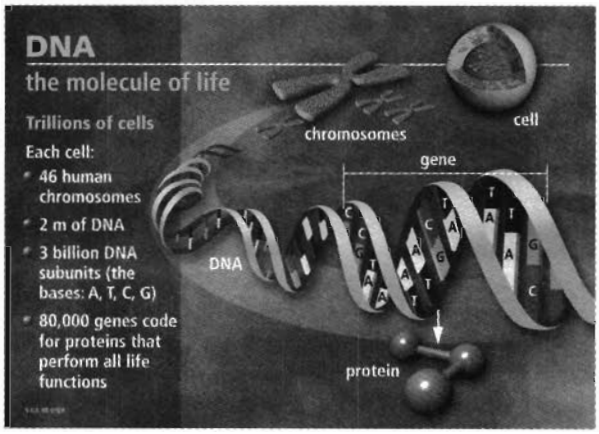
News & Views



Newsworthy Genetics

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The year 2000 has already been a wild ride for genetics in the news. Three areas have attracted particular attention.

(1) Agriculture has long been intentional about cross breeding for desired traits. Genetic technology now offers greater speed, precision, and breadth of sources for introducing characteristics. For example, a Vitamin A fortified strain of rice has been engineered. Largely unnoticed by the public so far in the United States, the use of these techniques has caused an uproar in Europe. People there were already uneasy about the trustworthiness of their food supply due to the "mad cow disease (bovine spongiform encephelopathy)" disaster. English beef producers fed ground beef byproducts such as cow brain to their cattle to speed growth. This practice made possible the spread of a brain disease lethal for cattle and apparently deadly for some humans who ate their meat. Also many European farmers feel that their livelihood is threatened by the gradual lowering of trade barriers against less expensive foods grown in North America. Together these concerns have led to prominently posted pledges by grocery stores and restaurants to offer no genetically modified products. It is also not unusual to see on European local news the latest incursion of protesters wearing full-body containment suits out in the fields trampling any genetically modified crops they can find. So far in the U. S., a few companies have taken up the issue. Frito-Lay has pledged not to use genetically modified corn and Gerber has promised to keep genetically modified products out of baby food.

(2) The media loves a horse race and has followed the wrangle between the private corporation Celera Genomics (CG) and the publicly funded Human Genome Project (HGP) over the ownership and release of new sequencing data. The even larger story that has been eclipsed is that a working draft of the human genome is already available and is quickly being refined. At last, this was officially announced in a joint press conference by Francis Collins (HGP) and Craig Venter (CG) on June 26, 2000. As readers of this journal probably realize, reading the sequence is far from being able to understand or use it, but the basic scientific advance of making the sequence known is extremely useful to better understand and begin intervention in the human genome. Labs have also completed most of the consensus sequence of some bacteria, yeast, the fruit fly *Drosophila melanogaster*, and the nematode *Caenorhabditis elegans*. Sequencing these organisms gives us models to study how the human genome functions.

(3) The first ten years of attempts at gene therapy had seen advance in technique but no clear cures. Then in the fall of 1999, Jesse Gelsinger, only eighteen years old, died in a gene therapy trial. During the ensuing investigation, charges have been made that the investigators gave insufficiently complete disclosure of the risks, hence undermining informed consent, and that they were increasing test dosages too aggressively. Concerns have also been raised about conflict of interest when an investigator will reap substantial financial rewards from a resulting new product and about failure at multiple research sites to report adverse reactions in trials to regulatory agencies. The University of Pennsylvania has announced that the investigators involved in the Gelsinger tragedy will no longer pursue research with patients.

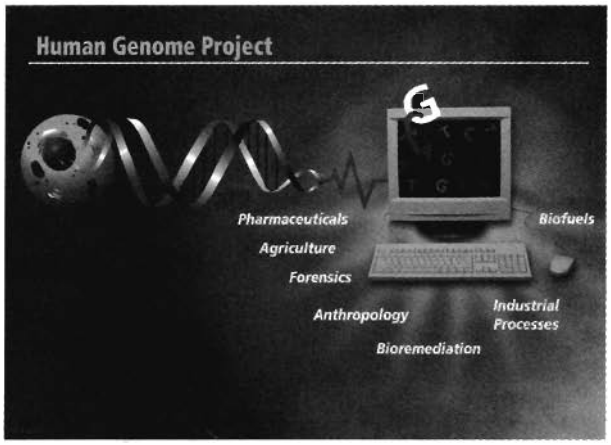
This nadir for gene therapy was followed in April 2000 by the announcement that Marina Cavazzana-Calvo and Alain Fischer had led a team to the first clearly lifesaving gene therapy. Two babies were afflicted with SCID-X1 (severe combined immunodeficiency-X1). Their bone marrow

lacked part of the genetic instructions needed for a working immune system. The physicians were able to insert the needed genetic material into marrow cells which then multiplied and displaced cells with the defective gene. At the time of the announcement in *Science*,[1] the babies were continuing to sustain their newly functioning immune systems ten months after treatment. It appears that here at last is confirmation that in some cases gene therapy may actually bring about a cure.

Whether in food production, research, or therapy, the Christian tradition calls us to use well the physical world to serve our neighbors. God sustains us in creation, restores us in redemption, and develops us in the continuing life-transforming work of the Holy Spirit. Reflecting God's image and called to follow Jesus Christ, we too should seek to sustain, restore, and improve the physical world temporarily entrusted to us. Genetic intervention is not inherently an arrogant affront to God. Pursuing it rightly can be part of our mandate to grow and serve. It can be a great boon in genuinely helping our neighbors, but it will never achieve a manmade utopia. It can only directly affect part of the physical world and the physical world is only part of what it is to be human. Genetic intervention is a developing capability that we are responsible to use to help humankind. No more. No less. Sorting out the best uses in the many practical decisions present and ahead is well worth our attention. ❋

Note

[1]Marina Cavazzana-Calvo, et al., "Gene Therapy of Human Severe Combined Immunodeficiency (SCID)-X1 Disease," *Science* 288, no. 5466 (April 28, 2000): 669–72.



Completing the Human Genome Project: The End is Just the Beginning

By Hessel Bouma III, ASA Fellow
Calvin College, Grand Rapids, MI
ASA Bioethics Commission chair

On June 26, 2000, the National Human Genome Research Institute[1] and Celera Genomics Corporation[2] announced the completion—or the beginning of the end—of the formal Human Genome Project (HGP). Officially begun in 1990, the project has a goal of mapping the 80,000–100,000 genes (estimates range from 50,000 to 140,000 genes) to the 24 human chromosomes (autosomes #1–22 and the X and Y sex chromosomes) and to sequence the 3 to 3.3 billion basepairs of DNA comprising the human genome. The HGP was projected to cost up to $3 billion and to take fifteen years to complete. It was begun with a common dream and faith—the dream that such knowledge would substantially benefit humankind; the faith that science would develop the necessary technology to make this project feasible and that humankind would use this knowledge wisely.

The HGP is the third massive science project undertaken by American scientists and society. In the 1940s, the Manhattan Project produced a test bomb and the two bombs dropped over Hiroshima and Nagasaki. From 1963 to the mid-1970s, the Apollo Project sought to place humans on the moon. Adjusted to current dollars, the Manhattan Project cost $22 billion, the Apollo Project cost $95 billion. Both these projects were undertaken with intense international competition. Both have had far-reaching consequences, socially as well as scientifically, unanticipated as well as anticipated, bad as well as

Graphic from the Department of Energy Human Genome Program web site: http://www.ornl.gov/hgmis

good. From the outset of the HGP, supporters recognized there would be enormous implications to this project and designated 3-5% of the funding for explorations into the HGP's Ethical, Legal and Social Implications (ELSI).

Initially the HGP was undertaken jointly by the National Institutes of Health with its interest and expertise in addressing genetic conditions and the Department of Energy with its interest and expertise in monitoring radiation safety and managing large projects. Commendable efforts were made to work cooperatively between these agencies as well as with a consortium of scientists from other countries. As a public, federally funded project, it was largely understood that the results of this project would be in the public domain, openly available to all. More recently, however the HGP has been joined by several private companies with biomedical interests, most notably Celera Genomics Corporation. Competition can be healthy, and may result in faster completion of the project, possibly with increased, independent confirmation of the data. But competition can also be unhealthy, focusing on individual egos, excessive consumption of resources, and "winners" who take all. The media has taken to emphasizing the competition and often the unhealthy dimensions of it. In reality, there is significant complementary work and cooperation between the public and private endeavors. The most significant difference is not who gets the credit or which techniques are most productive, but the accuracy of the information and whether and how the information is made available for the betterment of humankind. Will it be made available immediately in the public domain, or held privately, at least for a time, to give those who produced the information the first opportunity to use it? Which approach will encourage further research and development in the most stewardly fashion?

To achieve the goal of mapping and sequencing the human genome, scientists have undertaken mapping and sequencing several model organisms. To date, the HGP has elucidated the genomes of the common bacterium, *Escherichia coli* (4,405 genes on a single chromosome consisting of ~4.6 million basepairs)[3]; the yeast *Saccharomyces cerevisiae* (~6,600 genes, 16 chromosomes, 12 million basepairs); the nematode worm, *Caenorhabditis elegans* (~18,000 genes, 6 chromosomes, 97 million basepairs); and the fruit fly, *Drosophila melanogaster* (~13,600 genes, 4 chromosomes, 180 million basepairs). Work is also progressing on the laboratory mouse, *Mus musculus* whose genome is nearly as complex as the human genome; current reports suggest the sequencing phase of its genome is one-third finished. These endeavors will assist in assembling more complex genomes, identifying functional genes, and initiating the exploration of gene function and regulation. Concurrently, the National Science Foundation is funding work on the plant, *Arabidopsis thaliana*. Other groups are working on the genomes of numerous microbes, animals such as cows and dogs, and plants such as corn and rice.

Unlike the Manhattan and Apollo Projects, the HGP will not have as clear and concise an end-point. First, the occurrence of highly repetitive sequences of structural DNA render sequencing some regions very difficult and of diminished interest. It may be some years before these regions are fully sequenced. Second, what standard of accuracy should be met in the sequencing data? The more errors we are willing to accept, the sooner we can declare the sequencing completed. Third, is the project complete when the sequencing is finished, when the pieces are all assembled, when all the putative genes in the sequences have been identified, or when the information is all made publicly available? As a case in point, sequencing the *Drosophila* genome was first publicly announced as complete last fall before the fragments were assembled. This spring, the genome was announced as complete and publicly released although there were nearly 1300 small gaps remaining as well as major sequence voids at the centromeres of the four chromosomes. (Notice, too, talk of completing the human genome refers only to mapping and sequencing the entire genome, not to the ethical, legal, and social implications of the HGP.) Like constructing a sizeable and complex building, at some point we simply declare the project finished despite it not being 100% complete and accurate, and move on to put the product to good use while wrapping up loose ends.

Sequencing the human genome represents one of the most significant milestones in our biomedical understanding of human beings. Knowing all the genes and their structure should facilitate studies leading to our understanding of how these genes function and are controlled, the roles they normally play, and the effects of mutations in these genes on human health. That understanding, in turn, may enable us to develop better treatments for persons with genetic conditions. When coupled with developments in the fields of assisted reproductive technologies, developmental biology, and genetic engineering, the prospect for genetic cures through gene therapy looms large. Given the enormous number of genetic conditions already identified in human (see the Online Mendelian Inheritance in Man database[4] for the current, comprehensive listing), these are laudable goals for which completion

of the HGP represents a very significant hurdle to be cleared, but just the beginning of the race. Nor should anyone anticipate that it is all downhill from here.

In reality, knowing the structure and function of genes and mutated counterparts has opened doors first and foremost to diagnostic testing, then only gradually—and sometimes not at all—to better treatments. Throughout these gradual developments, scientists and clinicians—and sometimes families of affected persons—have envisioned gene therapy as the ultimate prize and portrayed it as imminent. Nearly fifty years ago, we first elucidated the molecular defect in sickle cell anemia. Only very gradually did we come to know how the various globin genes are expressed and find ways to manipulate their regulation. Diagnostic tests became available, and society hastily initiated mandatory genetic testing and engaged in considerable discrimination of persons who were carriers of or affected with sickle cell anemia. Gradually, medical treatments were developed such that life expectancy rose for persons with sickle cell anemia to reach an average today in the late 20s. Parents at risk of having a child with sickle cell anemia still have limited choices. They may choose not to have children. They might use preimplantation genetic diagnosis following in vitro fertilization[5] or CVS or amniocentesis followed by pregnancy termination to avoid having such a child. Or parents might take the one-in-four risk of having a child with sickle cell anemia, then take the very risky step and pursue a bone marrow transplant for their affected child—a procedure which is risky itself and may lead to further complications from graft-versus-host disease.[6] Perhaps the slow pace of progress in developing better treatments for this disease can be attributed to the fact that, until recently, scientists have been stymied by having to experiment exclusively on humans with sickle cell anemia. Now scientists have created transgenic mice as the first animal models for sickle cell anemia.[7] Will animal experimentation lead to faster development of better treatments? In the meantime, there still is no cure for sickle cell anemia.

For decades, scientists, clinicians, and parents of children with serious genetic conditions have envisioned a time when we could replace affected genes with unaffected ones—gene therapy. In 1991, two young girls underwent the first gene therapy for ADA deficiency. Both girls have not just survived but thrived, though they have needed several courses of gene therapy intervention and remain on an alternative treatment as a safeguard. Since then, gene therapy has been attempted in several hundred research protocols, mostly involving cancer treatments. Most unfortunately, the recent deaths of two patients during the course of gene therapy experimentation has been a chilling warning call. In a myopic focus on achieving the goal of successful gene therapy, some researchers apparently have recruited research subjects with inadequate informed consent and many have neglected to report suspected instances of adverse reactions. At the same time, French researchers have revealed what appears to be the first successful somatic cell gene therapy in two infants to cure the otherwise lethal condition of X-linked severe combined immune deficiency.[8]

We've learned some valuable lessons over the past several decades. We are much more reticent to rush to mandatory genetic screening than before, and discrimination is appreciably less overt. But there are valuable lessons still to be learned. When is diagnostic testing for a genetic condition appropriate? How can we eliminate genetic discrimination in employment and insurance? Is it hype or hope to foresee better treatments or a cure for sickle cell anemia and other genetic conditions in the near future? In the absence of effective treatments and cures, how can we best care for persons with genetic conditions?

Among the most beneficial aspects of the HGP will be (1) aiding persons affected by significant genetic conditions to flourish, (2) enabling medicine to profile drug therapies specifically for patients based upon their genetic makeup, and (3) providing information for biotechnology to produce safer and perhaps more economical medicinal products. Too often, these goals are overshadowed in the popular media by science fiction accounts of designing people through enhancement genetic engineering or cloning. People seem enamored with the idea of altering physical attributes such as height, intelligence, and a longer life span (some even suggest immortality). There is a smattering of evidence from animals that some genetic alterations can affect these traits. Many others are drawn to finding the genetic basis for behaviors such as sexual orientation and practice, infidelity, and criminal behaviors, usually to justify diminished human responsibility and free will. The HGP may gradually shed some light on these complex issues, but we should be cautious about premature speculation. It is highly unlikely that these endeavors will become prominent outgrowths of the HGP in the foreseeable future.

As the formal HGP winds to an end, its many implications may very well be just beginning. First,

as more and more genomes are sequenced, the molecular data will provide considerable evidence on the genetic similarities and dissimilarities between humans, other primates, and all living things. Will it clarify issues of evolutionary lineage and human origins? Second, the ethical, legal, social implications of the HGP will continue. Will it change how we view and value ourselves as persons? Can we maintain our individuality and privacy, avoid genetic discrimination, and value diversity? Will we care for persons for whom treatments and cures are still elusive? Can we work to assure the benefits of the HGP are accessible to everyone? These are exciting times to be a scientist and a Christian. The challenges and opportunities are immense. The end of the HGP is just the beginning. ✻

Notes

[1] http://www.nhgri.nih.gov/index.html
[2] http://www.celera.com
[3] F. R. Blattner, et al., "The Complete Genome Sequence of *Escherichia coli* K-12," *Science* 277 (1997): 1453–74.
[4] http://www3.omim.ncbi.nlm.nih.gov/omim/
[5] Xu Kangpu, et al., "First Unaffected Pregnancy Using preimplantation Genetic Diagnosis for Sickle Cell Anemia," *Journal of the American Medical Association* 281.18 (1999): 1701–6.
[6] Eric Kodish, et al., "Bone Marrow Transplantation for Sickle Cell Disease: A Study of Parents' Decisions," *New England Journal of Medicine* 325.19 (1991): 1349–53.
[7] C. Paszty, et al., "Transgenic Knockout Mice with Exclusively Human Sickle Hemoglobin and Sickle Cell Disease," *Science* 278 (1997): 876–8; and T. M. Ryan, et al., "Knockout-Transgenic Mouse Model of Sickle Cell Disease," *Science* 278 (1997): 873–6.
[8] M. Cavazzana-Calvo, et al., "Gene Therapy of Human Severe Combined Immunodeficiency (SCID)-X1 Disease," *Science* 288 (2000): 669–72.

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. richard@tcainternet.com

Kenneth Bakken, *The Journey Into God: Healing and Christian Faith*, Augsburg Fortress, 2000
Arthur Balfour, *Theism and Humanism: The Book that Influenced C. S. Lewis*, Inkling Books, 2000
Ray Bohlin, *Creation, Evolution, and Modern Science*, Kregel, 2000
Michael Budde, *The Magic Kingdom of God: Christianity and Global Culture Industries*, Westview, 2000
Terry Burnham & Jay Phelan, *Mean Genes: From Sex to Money to Food, Taming Our Primal Instincts*, Perseus Publishing, 2000
Frank Close, *Lucifer's Legacy: The Meaning of Asymmetry*, Oxford Univ. Press, 2000
John Collins, *The God of Miracles: An Exegetical Examination of God's Action in the World*, Crossway Books, 2000
S. B. Cowan, ed., *Five Views on Apologetics*, Zondervan, 2000
Kerbert Cutner, *Jesus: God, Man or Myth: An Examination of the Evidence*, The Book Tree, 2000
Dennis Richard Danielson, *The Book of the Cosmos: Imagining the Universe from Heraclitus to Hawking*, Perseus Publishing, 2000
Mark Futato, *Creation: A Witness to the Wonder of God*, P&R Pub., 2000
Henry Gee, *In Search of Deep Time: Beyond the Fossil Record to a New History of Life*, Free Press, 1999
Fred Heeren, *Show Me God: What the Message from Space Is Telling Us About God*, Day Star, 2000
Robert Herrmann, ed., *God, Science, and Humility: Ten Scientists Consider Humility Theology*, Templeton Foundation Press, 2000
Erazim Kohak, *The Green Halo: A Bird's-Eye View of Ecological Ethics*, Open Court, 2000
Richard Lewontin, *The Triple Helix: Gene, Organism, and Environment*, Harvard Univ. Press, 2000
John Lienhard, *The Engines of Our Ingenuity: An Engineer Looks at Technology and Culture*, Oxford Univ. Press, 2000
Jeffrey McKee, *The Riddled Chain: Chance, Coincidence and Chaos in Human Evolution*, Rutgers Univ. Press, 2000
Richard Milton, *Shattering the Myths of Darwinism*, Park Street Press, 1997
J. P. Moreland & Scott Rae, *Body and Soul: Human Nature and the Crisis in Ethics*, IVP, 2000
Henry Morris, *Biblical Creationism: What Each Book of the Bible Teaches About Creation and the Flood*, Master Books, 2000
Ralph Muncaster, *Creation vs. Evolution: The Latest Scientific Discoveries*, Harvest House, 2000
Mark Noll & David Livingstone, eds., *Evolution, Science and Scripture: Selected Writings of B. B. Warfield*, Baker Books, 2000

Young Scientists' Corner

Scientific Ethics: A Realm for Partnership?

by Catherine H. Crouch, ASA Student Member, 9 Oxford St., Gordon McKay Labs, Cambridge, MA 02138, crouch@fas.harvard.edu

As policy debates over public funding of embryonic stem cell research have unfolded over the past year or so, I have found myself increasingly uncomfortable. Uncomfortable partly because the editorial pages of *Science* imply that the mainstream scientific community unanimously supports government funding of embryonic stem cell research and assumes ethical issues can be resolved along the way. Uncomfortable partly because I am convinced that from the moment of fertilization, a developing fetus should not be treated as simply a resource for enhancing the health of people who are further along in their development. Uncomfortable partly because I am a physicist, not a biologist, and am not sure I fully understand the scientific issues. And, finally, uncomfortable because I am not certain what to do with my discomfort beyond e-mailing comments to the National Institute of Health regarding their proposed ethical guidelines. What is a postdoc in applied physics to do about attitudes in the scientific community or federal policymaking in areas outside of her field?

Embryonic stem cell research is among the most visible of a number of ethical issues related to doing science. Some other current issues that come to mind quickly are closer to my field of expertise: global climate change, nuclear waste disposal, nuclear weapons testing and storage, and federal spending on missile defense systems of questionable effectiveness. With these issues, I feel reasonably sure I understand the scientific issues involved. But I still find myself wondering how to respond. Am I called to engage in the political process surrounding these issues, and, if so, at what level? Should I write to my Representative or Senator? Join a lobbying organization? Look for a job on the staff of a legislator or in the national scientific organizations that deal with these issues? Run for national political office?

As scientists in today's increasingly technical society, our knowledge gives us increasing potential for power and influence, which few of us use effectively, if at all. While my anecdotal experience is that many—perhaps even most—scientists are socially concerned, it also seems that most are not particularly engaged in policymaking. Furthermore, most of us are not prepared, either by our profession or by society, to think about the ethical and political questions that arise at the boundaries of our work. (Does anyone know of any Ph.D. programs that include training in ethics?[1])

I suspect that there are two reasons for this. First, mastering and then staying abreast of scientific work is sufficiently time-consuming that it is not clear if there is time (at least until relatively late in one's career) to become both educated and involved in ethical and political decision

making. (One of my coworkers has decided that he must choose between his concern for ethics and policy and his interest in research science, so he has taken a job with a policy think-tank instead of pursuing a "scientific" career.) I do not have enough time to keep up with all the journals related to my field; I have accomplished all I can hope for if I regularly scan over the potentially related abstracts. To become well educated in another scientific area, much less to become a sophisticated thinker on ethical or political issues, seems almost out of the question.

Second, most of us became scientists because of a love for the natural world and an aptitude for scientific reasoning. Ethical and political thinking and involvement require different skills than analytical scientific research. It is also less likely that there exists a single, obviously correct solution to any problem. We scientists, however, are trained to pursue the one right answer, and may find it difficult to deal with other kinds of problems. In my own work on improving undergraduate science education, I often find myself wishing that all students were exactly the same, so that all students would respond the same way to a given pedagogy, just as all hydrogen atoms respond in the same way to a particular excitation. I imagine a similar level of frustration arises for scientists who deal with ethical questions without simple answers, or for scientists dealing with political processes that often seem (at least from the outside) to function counter to all rational expectations. Retreating into the laboratory seems appealing in face of such ambiguities.

This is where we need each other. Jesus called his followers into the Church where individuals with different gifts or inclinations serve together. The challenges of living out the love of God in a fallen world are too big to tackle alone! To respond to science-related ethical issues, we need fellow scientists who are followers of Jesus to encourage us not to bury our heads in the sand, but to think with us about the scientific issues and to plan strategies together that impact the broader scientific community. We also need the rest of the Church. We need its rich history of theological understanding and experience on which Christian ethical thinking must be based. We need our brothers and sisters who have devoted their lives to acquire understanding in ethics and politics. If only scientists think about these issues, our ideas will be the poorer for it.

What better mission exists for a professional association of Christians in science than to provide resources and partnership for responding to ethical issues? Organizations, like the ASA and the Christian Medical and Dental Society, provide information on ethical

To respond to science-related ethical issues, we need fellow scientists who are followers of Jesus to encourage us not to bury our heads in the sand, but to think with us about the scientific issues, and to plan strategies together that impact the broader scientific community.

We also need the rest of the Church. We need its rich history of theological understanding and experience on which Christian ethical thinking must be based.

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issues for their members.[2] This information could include materials designed to educate scientists about issues outside their own fields (for example, a guide to the biology of embryonic stem cell research written for scientists not in biology). Going a step further, such organizations could connect concerned members to opportunities for in-depth training in ethical and political issues, and can provide more broadly aimed workshops and seminars. Most important, such organizations can help members with common concerns to connect to other Christians with expertise in ethics or politics.

If the most valuable role that a professional organization can play is bringing together concerned individuals, then disagreement, if communicated in love and humility, can be used by the Holy Spirit to produce clearer thinking.

I want to find other scientists—particularly, but not only, biologists—as well as other Christians who are trying to think about embryonic stem cell research out of a Christian framework. I want to pray with people, who are broken hearted before God, over the brokenness of our world.

An obvious challenge to the connected community of Christian scientists that take on such a mission is the disagreement among Christians about how to think and respond to ethical issues. However, the ASA seems to have found a strategy for responding to the problems raised by teaching evolution, even though I doubt there is anything resembling complete agreement on that within the ASA membership. If the most valuable role that a professional organization can play is bringing together concerned individuals, then disagreement, if communicated in love and humility, can be used by the Holy Spirit to produce clearer thinking.

As I write these words, I am anticipating the birth of my second child in just a few weeks. I am acutely aware that not long from now, I will have even less time and energy than at present to devote to thinking about embryonic stem cell research, much less doing anything about it. But this is where prayer and partnership come in. I need partners, more actively working than I, who will encourage me to pray, and for whom I can pray. May God send such partners my way. ❋

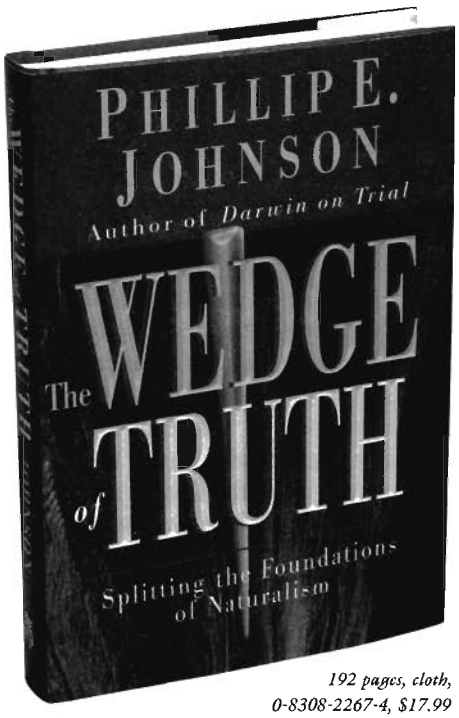
I need partners, more actively working than I, who will encourage me to pray, and for whom I can pray.

Notes

[1] A number of Ph.D. programs provide training in *research* ethics, e.g., what constitutes falsification of data, appropriate use of information about others' research, and so on; I am more interested in training in general ethical thinking, which for a Christian would be grounded in theology.

[2] Some resources which are available for people interested in these issues:
- The ASA web site (http://www.asa3.org) includes links to ethics resources on the web and ethics-related materials that have been published recently in *PSCF*.
- The Christian Medical and Dental Society has an ethics commission which has addressed a number of bioethical issues through position papers: see http://www.cmds.org/ethics/
- The Coalition of Americans for Research Ethics has an extensive web site on embryonic stem cell research at http://www.stemcellresearch.org/
- The University of Pennsylvania has a large center for bioethics, with information at http://www.med.upenn.edu/bioethics/

CHALLENGING Naturalism



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In his new book Phil Johnson introduces the reader to what he calls the wedge strategy—just what he along with fellow members of the intelligent design movement are trying to accomplish. Seeing himself as the sharp, thin edge, Johnson looks to the philosophers, scientists and others on the team to provide the ever–widening and deepening research aspects of the program. *The Wedge of Truth* serves as a state of the union address in which he assesses the progress of their cultural critique and chronicles key interactions he and others have had with scientists, journalists, educators and the courts. He cogently summarizes the main lines of the intelligent design argument and counters the most recent criticism. But more than this Phil clarifies what he regards to be of central importance in this debate: We must call into question the uncritically accepted authority of those who, in the name of science, presume to define a priori for all society the very nature of truth and rationality in terms of naturalism. The mythology of this secular priesthood must be exposed for what it is so that public debate and education about the deepest, most profound questions of life can again take place. And this should begin, says Johnson, with a consideration of Jesus Christ as the Logos of all things.

"Phillip Johnson is our age's clearest thinker on the issue of evolution and its impact on society." **Michael Behe**

Phillip Johnson graduated from Harvard University and the University of Chicago Law School. He was a law clerk for Chief Justice Earl Warren of the United States Supreme Court and has taught law for thirty years at the University of California, Berkeley. His previous books include *Darwin on Trial, Reason in the Balance, Defeating Darwinism by Opening Minds* and *Objections Sustained.*

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Theological Analysis of Selected Recent Creationist Assertions Concerning the Occurrence of Death before Sin

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Old-earth creation models such as theistic evolution and progressive creation accept the occurrence of death before sin. Theological arguments centered on God's character – his omniscience, omnipotence, and loving nature – are developed by recent creationists to argue against the occurrence of death before sin. Likewise, the atoning work of Christ is understood by recent creationists to be incompatible with death before sin. Analysis of these assertions reveals that theological argumentation cannot preclude an old earth creation in which death of animals and humans occurred before sin. Conversely, it can be argued theologically that such a world is to be expected.

In one sense, all models of origins reduce to two: (1) those that posit a recent creation in the order of 10,000 years or less, and (2) those that involve an old earth. Recent creationists claim that physical death and suffering is the result of human sin. Therefore, evolution could not have occurred, and the earth must be very young. They offer significant theological arguments that, if accepted, would deny death and suffering prior to human sin. In contrast, progressive creationists and theistic evolutionists, while disagreeing on the extent and efficacy of evolution in accomplishing God's objectives, do agree that the earth is very old and that there was death as evidenced by fossils during the entire history of life on earth – before humans and thus before sin. Among evangelical Christians, the debate seems unending. However, if no theological defense can be made for the occurrence of death, injury, disease, and suffering before human sin, then no old-earth position is tenable.

Old-earth creationists face a difficult challenge. It is often not enough to simply say that the weight of scientific evidence is on their side. As Johnson notes:

> Most evangelicals have steered clear of interpreting the Genesis narratives other than as straightforward historical accounts. Underlying this hesitation is a deep-seated fear that once we have departed from tradition in this way, we will find ourselves on a "slippery slope" that will lead ultimately to the denial of key doctrines such as the resurrection and the collapse of biblical Christianity.[1]

Three recent creationist assertions concerning death, suffering, and disease will be critiqued in this paper with the goal of arguing that old-earth models such as progressive creation or theistic evolution are not only scientifically and theologically supportable, but indeed preferable to recent creation models. A further goal of this paper is to encourage Christians not to fear science and scientific theories. In fact, Christian students should be called to careers as geologists, paleontologists, astronomers, and evolutionary biologists.

Assertion #1: Death would not be part of a good creation created by a good, omnipotent, and omniscient God.

Recent creationist Stambaugh says:

> The Bible states that God created everything in an idyllic fashion ("very good," according to Gen. 1:31). The earth, animals, and man cooperated in harmony and peaceful coexistence. God gave man the freedom of choice – to choose to obey or disobey him.

*ASA Member

> However, if we view the timing of Rom. 8:19–21 as dating from Gen. 1:1, we can offer no credible defense for a belief in a God who is good, loving, just, and merciful, for this "groaning" world was His plan.[2]

Ham adds the idea that "death, bloodshed, and suffering of living creatures were not possible before the Fall. It was a perfect world, sustained totally by the infinite Creator."[3] Regarding old-earth progressive creationism, Morris declares: "We literal creationists do see problems in this idea, however. The concept of an omnipotent, omniscient, loving, caring God devising such a scheme somehow seems to stick in our mental throats whenever they ask us to swallow it."[4]

Analysis

Ratzsch suggests:

> We have to be extremely careful here not to put undue weight on our own constructions of what *good* means. [Recent] creationists understand *good* as automatically implying lack of animal death, animal suffering or animal predation and as implying efficiency, economy and so forth. But it was God who saw the creation as good, and just as his thoughts are not ours and his ways are not ours, his judgements of good might be a bit beyond ours as well.[5]

Lodahl writes:

> The created order truly is capable of fulfilling God's purpose for it as the place where relationship between God and human beings takes place. This points us toward the specific way in which creation is "very good": because it is the sphere in which real relationship is possible with the Creator, because its real otherness is upheld, indeed cherished, by God. Philosophers have argued for centuries over whether this is the best possible world, and the only suitable answer is, "That all depends." If you think the best possible world would be one without pain, without threat or hurt or risk, where "a good time is had by all," then this is not it. If you consider the possibility that the best possible world would be one that best suits God's purposes of establishing real, covenantal relationship with humans, complete with freedom and the risks that entails, with the realities of struggle and pain and the growth those enable, then perhaps this world comes awfully close.[6]

While recognizing the importance of relationship and free will, Christians shrink away from accepting as good those elements of creation that cause pain and suffering. In fact, theologians have labeled these undesirable aspects of creation as *natural evils* and attempt to understand their presence (as well as the presence of moral evil) by developing theodicies. A theodicy is the "theoretical justification of the goodness of God in the face of the presence of evil in the world."[7] With regard to the natural world, Reichenbach explains:

> It is he who guided its evolution, so that in the created he might realize the purposes for which he created. But if God made and continues to work with the world, how is it possible to reconcile his perfect goodness with the apparently unwarranted and wanton suffering due to natural (i.e., nonhuman-purposed) causes which plagues human (and animal) existence? How can a God characterized by omnipotence, omniscience, and perfect goodness be directly or indirectly the cause of ...?[8]

Here the reader can insert as nasty a list of diseases, disasters, birth defects, or predators as desired. Reichenbach explores several types of theodicies that attempt to find a solution to the problem of natural evil. He favors a theodicy based on natural laws and free will.

An important presupposition for a theodicy based on natural laws is that "a world containing significantly free persons making choices between moral good and evil and choosing a significant amount of moral good is superior to a world lacking significantly free persons and moral good and evil."[9] This is essentially the Free Will Defense of Plantinga.[10] Reichenbach's approach is to extend the free will defense, traditionally applied to moral evil, to natural evils. Swinburne agrees, explaining that "if the free-will defense works in explaining why

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God might permit the existence of moral evil, then it also provides an explanation of why God might bring about the existence of much natural evil."[11] Polkinghorne completes the parallel by naming this approach a "free-process defense."[12]

Reichenbach's argument is:

> The natural evils which human persons (and animals) experience (by and large) are not willed by God, but are the consequences of the outworking upon sentient creatures of the natural laws according to which God's creation operates. This creation, in order to make possible the existence of moral agents (in this case, human persons), had to be ordered according to some set of natural laws. Consequently, the possibility arises that sentient creatures like ourselves can be negatively affected by the outworkings of these laws in nature, such that we experience pain, suffering, disability, disutility, and at times the frustration of our good desires.[13]

Reichenbach further argues that the alternative, "a world operated by miracle is incompatible with a world inhabited by significantly free moral beings" and that, assuming the above presupposition is true, "it was impossible for God, in creating, to create a world which was not operated by natural laws."[14] He elaborates:

> In a world which operates according to divine miraculous intervention, there would be no necessary relation between phenomena, and in particular between cause and effect ... There would be no regularity of sequence, no natural production of effects.
>
> But without the regularity which results from the governance of natural laws, rational action would be impossible. Without regularity of sequence, agents could not entertain rational expectations, make predictions, estimate probabilities, or calculate prudence. They would not be able to know what to expect about any course of action they would like to take ... Hence, agents could not know or even suppose what course of action to take to accomplish a certain rationally conceived goal ...
>
> But proposing action and acting on that proposal are essential for an agent's determination as a moral being. "Good" is predicated of moral agents when proper intentions come to fruition in right conduct; "bad" when improper intentions result in wrong conduct. But since they would be unable to rationally conceive what actions to take in order to achieve certain goals, and since they could not perform the actions, a world operated by miracle would prevent moral agents from formulating or carrying out their moral intentions. In effect, it would become impossible for agents to be moral beings.[15]

Lewis illustrates the problem of a world operated by miracle. He invites us to:

> Conceive of a world in which God corrected the results of this abuse of free will by His creatures at every moment: so that a wooden beam became soft as grass when it was used as a weapon, and the air refused to obey me if I attempted to set up in it the sound waves that carry lies or insults. But such a world would be one in which wrong actions were impossible, and in which, therefore, freedom of the will would be void; nay, if the principle were carried out to its logical conclusion, evil thoughts would be impossible, for the cerebral matter which we use in thinking would refuse its task when we attempted to frame them.[16]

Polkinghorne considers it likely that only "a universe in which we could entertain a free-process defense, would be one in which there could be people to whom the free-will defense could be applied."[17]

God's creation can be considered good, then, in that it accomplishes his will—allowing rational, morally free agents to come into existence and make free choices to love and obey God and be in relationship with him.

Those who object to the above theodicy for natural evils often suggest that God could warn people of impending physical perils and thereby keep them from harm. But a world filled with divine warnings of physical danger and miraculous protection from physical hazards might as well be a world where God verbally warns people of every foreknown danger. Swinburne argues against this sort of world because this sort of world would allow humans to know for *certain* that there is a God.[18] This kind of world would not be:

> A world in which men had a significant choice of destiny, of what to make of themselves and the world. God would be too close for them to be able to work things out for themselves. But the whole point of the free-will defense is that a good God might give to man a choice of destiny; if he gave to men verbal knowledge of the consequences of their actions, he would not be able to give that choice. Proximity to God is no doubt a good thing; but a God has reason

> to ensure that we only get to that state as a result of our choice (e.g., in another world as a result of our conduct in this one).[19]

Swinburne concludes: "There must be natural evils if men are to have a significant choice of destiny; which is why a good God might well bring them about."[20]

God's creation can be considered good, then, in that it accomplishes his will—allowing rational, morally free agents to come into existence and make free choices to love and obey God and be in relationship with him. Regularity of natural laws is essential to developing rational thought. In fact, it is essential to life on earth. For example, organisms require the predictability of gravity to learn to walk, run, swim, and fly effectively. But the same laws of gravity that permit learning to walk and run without falling also result in injury or death if one falls from a significant height or is struck by a falling tree limb. Similarly, water is essential for life but it can also kill us. Fire warms us and cooks our food but it can also burn and destroy. Note that regularity of natural law does not preclude miracles. Indeed, there must be an overall regularity for a miracle to be recognized. The inexorable regularity of natural laws allows cause and effect relationships to be learned and rational action to exist. Rationality, in turn, is prerequisite to being a moral agent.

How do we explain the "groaning" world of Rom. 8:19–22? Recent creationists claim that the groaning creation described in Romans 8 describes the physical changes (thorns, pain, death) that came about in creation as a result of Adam's sin.[21] As Ross explains, though, the Romans 8 passage, while telling us when the bondage to decay will end, does not tell us when it began or what the nature of the bondage is.[22] Ross understands the "groaning" and "decay" to be the environmental degradation that results from the disruption of our relationship to God and to creation. Significantly, the Bible does link physical degradation of the land to moral decay (Isa. 24:5, Hosea 4:1, 3). Blocher says:

> If man obeyed God, he would be the means of blessing to the earth; but in his insatiable greed, in his scorn for the balances built into the created order and in his shortsighted selfishness he pollutes and destroys it. He turns a garden into a desert (cf. Rev. 11:18). That is the main thrust of the curse of Genesis 3.[23]

Pollution, greed, and ecological destruction are not new to modern humankind. Archeological evidence indicates that ancient civilizations were more than capable of destroying the ecological base on which they depended.[24]

In summary, the Free-will Defense as applied to natural evils states that a world with moral agents is superior to a world without them and that it would be impossible to create such a world without the regularity of natural laws. There is, then, a morally sufficient reason for natural evil, and the presence of evil in creation is not necessarily at odds with a *very good* creation created by a good, omniscient, and omnipotent God.

Assertion #2: Death before sin negates the atoning work of Christ.

Ham tells us:

> Death and bloodshed before Adam sinned makes nonsense of the whole basis of the atonement. It would mean that death was not the penalty for sin, (since it existed for millions of years *before* sin), and therefore death could not be used to atone for sin. This would destroy the reason why Christ died and the meaning of the resurrection.[25]

Speaking of the use of animals in the Old Testament sacrifice of atonement, Stambaugh adds:

> If there was animal death before the fall of man, then God and all those who followed His pattern did useless acts. One must observe that in the atonement the animal loses its life in the place of the human. If animal death existed before the fall, then the object lesson represented by the atoning sacrifice is in reality a cruel joke ...
>
> If we believe that death has always existed, then we make a mockery of the death of Christ ... If death is not the penalty for sin, then Christianity is meaningless. The death of Christ was made necessary because of man's sin. Man's sin brought death, which in turn brought God's Son to pay the penalty in our place.[26]

Finally, in response to suggestions by old-earth creationists that sin led only to spiritual death, Morris asks: "Why would Christ have to die *physically* ... in order to atone for man's "spiritual" death?"[27]

Analysis

There are difficulties at several levels with this understanding of the relationship between sin, death, and the atonement. First, although human death is linked with human sin (Rom. 5:12–13 and 1 Corin. 15:21–22), it moves beyond the clear teaching of the Bible to claim that nonhuman death is also the result of human sin. The context of the passages above is exclusively human. Animals are considered amoral creatures, incapable of sinning, and therefore not under any penalty of death and not in need of a restoration of relationship with God. Animal

death occurring for whatever length of time before the entry of sin cannot, therefore, be the result of sin. It is an unwarranted extrapolation to extend the consequences of human sin to the broader animal world. Animal death before human sin does not diminish or make a joke of or mockery of the religious significance of the Old Testament sacrificial system or the atoning sacrificial death of Christ. There was no need of atonement before there was sin.

Secondly, just because sin required atonement which was associated with the death of animals and Jesus' death, this does not mean that all death in all times and all places is associated with sin. Ross states it this way:

> While it is true that there is no remission of sin without the shedding of blood, Christ's blood, it does not necessarily follow that *all* shed blood is for the remission of sin. (To say there could have been no bloodshed before sin is to make the same exegetical error as made by those who claim there were no rainstorms or rainbows before the Genesis flood.)[28]

Thirdly, does the fact that Christ died physically *prove* that the first experience of physical death by people came about as the result of sin? Did Christ *have* to die physically for atonement to occur? Did animals *have* to be sacrificed in Old Testament times to provide atonement? In discussing the necessity of the atonement, Grider dismisses the assertion that the atonement provided was the only kind open to God. While stating that some kind of atonement was necessary "if the holy God was to forgive and cleanse us sinful human beings," Grider points out that "God was surely free to choose the method of atonement: a different kind of death, or even a method other than death. God is God. We are the creatures, and the creatures do not tell God that he is required to act in certain ways."[29]

Lastly, atonement can be defined as the "bringing of people back into relationship with God."[30] It is the doctrine that Jesus' life, death, and resurrection saves us from sin and reconciles us to God. It is the restoration of relationship broken by sin. Theories or models of atonement attempt to explain *how* Christ's work on the cross accomplishes this restoration.

> It is noteworthy that there has never been a single "official" doctrine of the Atonement approved by church council or creed; rather, what we find are many different attempts to view the cross of Jesus from differing angles and from within different historical and social contexts.[31]

Various models include *Christus Victor*, Ransom Theory, Satisfaction Theory, Penal (Punishment) Theory, Moral Influence Theory, and the Governmental Theory.[32] Recent creationist language describing the atonement suggests adherence to the penal theory of atonement of the Calvinist-Reformed tradition. Penal theory "starts from the ideas of the inviolability of law and the justice of God. God is perfectly just, and the divine law of punishment can never be set aside. Sin was seen as a breaking of law, and all such violations must be punished so that the law can be satisfied. God's justice is such that sin cannot go unpunished."[33] "God's justice will not allow Him to forgive without sin being fully punished."[34] Finally, "because of the cross, believers have nothing to fear. The requirements of the law have been met. From this point of view the cross represents Christ's receiving of that penalty of sin that was our due."[35]

Recent creationists' insistence on understanding all death as a penalty for sin leads them to promote one interpretation of Christ's atonement to the exclusion of the other views held by the wider Christian Church.

Other theories of the atonement, however, do not link Christ's death to the paying of a penalty or being punished. Arminian-Wesleyan tradition, for example, holds the Penal theory to be inadequate and unbiblical.[36] Grider declares that "Scripture never states that He was punished for us or that He paid the penalty for us. Scripture always states instead that He suffered for us."[37] Taylor adds: "The perfect unity of purpose which existed between Jesus and His father excludes all theories of vindictive punishment."[38] Differences in understanding extend to the meaning of the animal sacrifices of the Old Testament as well. Arminian-Wesleyan theologians speak of the person offering the sacrifice as identifying with the sacrifice as his representative before God;[39] whereas the Calvinist-Reformed tradition speaks of the animal, in dying, "taking the punishment due the worshiper for his sins."[40] Recent creationists' insistence on understanding all death as a *penalty* for sin leads them to promote one interpretation of Christ's atonement to the exclusion of the other views held by the wider Christian Church.

Assertion #3: Long ages filled with death and suffering is not a process that an efficient, wise, caring, and loving God would use.

Morris says:

> One of the hardest things to understand is how anyone who claims to believe in a God of love can also believe in the geological ages, with their supposed record of billions of years of suffering and death before sin came into the world. This seems clearly to make God a God of waste and cruelty rather than a God of wisdom and power and love.[41]

Similarly, "Evolution is the most wasteful and most cruel process that one could ever devise by which to 'create' men and women."[42] And Morris asks: "Had God been experimenting, trying to find something He could call His image? Did He not know what He wanted? Was He not powerful enough to create it without so many missteps? If the creation and redemption of man was His purpose, why did He wait so long?"[43]

Analysis

Here, too, we must be careful not to apply human parameters to God. We are time-bound creatures and, at least in this culture, quite concerned about wasting time and maximizing efficiency. Ratzsch responds:

> Nor is it obvious that wastefulness would be a concern to God. Nature produces a lavish profusion of everything from beetles to grass blades to rocks to stars. Indeed, what would *wasteful* even mean in the context of omnipotent ability to create anything and everything from nothing with a word? And the creation does not seem to be defined by ruthless efficiency. Why would efficiency be a concern to the eternal God? He is not going to run out of time, energy, or resources.[44]

If efficiency is an important part of God's character, why did he not just bring the entire creation into existence in the blink of an eye? Why take six days? Why not six seconds? Why create the ostrich described in Job 39:13-18 that *wastes* its eggs by allowing them to be trampled and that treats its young as if they were not hers? Why lavish so much beauty on a flower that lasts but a day (Luke 12:27-28)? Why create a Leviathan that is of no use to people (Ps. 104:26)? Ratzsch observes:

> Maybe God enjoys watching his creation operate. Maybe he delights in seeing processes he has designed unfold. Maybe a few billion years watching an incredibly intricate, complex, beautiful creation in exquisite operation does not strike him as a waste of time. And maybe we should be a bit cautious about humanly decreeing that it would be.[45]

Recent creationists claim that old-earth models portray God as wasteful and cruel and allowing too much suffering. But if quickness in time is important to avoid these charges, the same accusations can be applied to post-sin history. Ross observes:

> God could do much right now to reduce our suffering. But a loving, merciful God allows the epitome of His creation—humankind—to suffer discomfort, illness, injury, and death. God even calls the death of His saints precious (Ps. 116:15). Could it be that God's purposes are somehow fulfilled through our experiencing the "random, wasteful, inefficiencies" of the natural realm He created.[46]

We must be careful not to apply human parameters to God ... Can human beings always know what a caring and loving God will do? ... God expects his people to trust his goodness and care, even in the face of death and misery.

Can human beings always know what a caring and loving God will do? In the book of Job, we learn that Job's seven children and many of his servants and animals are killed. Although God prospers him in the end, his seven dead children are not brought back to life and God never, to our knowledge, explains to Job the heavenly understanding with Satan that led to Job's ills. Is this what we would "expect" a loving God to do? Then, as now, God expects his people to trust his goodness and care, even in the face of death and misery. Similarly, the physical destruction of the various ethnic groups inhabiting Canaan may be explained as part of God's overall plan of redemption. But these violent and bloody conquests are not necessarily what we would "expect" a caring, loving God to do. A note of caution should accompany any claim to know how God views death as it occurred, not only over the vast geologic ages but also in recorded history.

A Further Note Concerning Human Death

The likelihood of human death and suffering before sin is a hard concept to accept. It is an old debate. Hollinger notes:

> Some have argued that the entrance of sin changed the nature of death and certainly brought spiritual

> death, but that even without the fall there would have been the natural biological process of the life cycle, which moves from the inception of life, through various stages, to its conclusion ... Other theologians, however, have contended that physical death per se, not just its sinister components, is the result of sin.[47]

It is worth noting that theologians have wrestled with the question of death long before the advent of evolutionary theory. For example, in answering the question, "Why was man, created immortal, given food to eat in Paradise?" Augustine states:

> It is difficult to explain how man was created immortal and at the same time in company with the other living creatures was given for food the seed-bearing plant, the fruit tree, and the green crops. If it was by sin that he was made mortal, surely before sinning he did not need such food, since his body could not corrupt for lack of it ... no one will go so far as to say that there can be a need of food for nourishment except in the case of mortal bodies.[48]

"One of our most appealing and persistent myths is that of the Golden Age, a time before the discovery of good and evil, when death and disease were unknown."[49] Sigerist, reviewing human paleopathological evidence concludes that "not only did man at all times for tens of thousands of years suffer from many kinds of ailments, but animals, millions of years before the advent of man, were also plagued with disease."[50] All available evidence indicates that humans have always experienced the kind of world we see around us now, a world which includes death, sickness, parasites, predation, storms, earthquakes, and the possibility of accidents. Bear in mind the human body is made of the same material as other mortal animals. We are subject to the same kinds of injuries and deaths that animals have suffered for millions of years. Would God protect all humans from being severely cut and bleeding to death, or falling from a height and being killed or paralyzed, or drowning, or choking to death, or being crushed by a falling tree or rock? To claim that human beings, before sinning (but with our present physical constitution), would not suffer injury and mortality is to make the problematic claim that human life would be constantly maintained by miracle.

We need to bring to this argument, too, the conclusions of many biblical scholars that the Bible, particularly the primeval history recorded in Genesis 1–11, is not to be understood as teaching science or history as we understand it. Theological truth is often not connected to the time-specific context, content, and understanding of the passage containing it. As Galileo liked to say, the Bible teaches us "how one goes to Heaven, not how the heavens go."[51] The scientific study of God's creation allows us to glimpse the "how" of God's creating. The validity of this complementary approach to science and the Bible has been vindicated time and again. The strength of extra biblical evidence has convinced many Christians to reassess the meaning of many aspects of the Genesis stories. To most Christians, it is no longer an issue that the earth is not the center of the universe or that the earth is very old. It is my contention that this reexamination of the Genesis 1–11 narratives should encompass the biological world as well as the celestial and geological. Given the strong evidence for an old earth, the paleontological evidence for the occurrence of death and disease throughout the history of life, and given the implications of Polkinghorne's "free-process defense," can Christians also come to accept that living things (including humans) have always been mortal and there never was an *idyllic* Garden of Eden?

It is my contention that this reexamination of the Genesis 1–11 narratives should encompass the biological world as well as the celestial and geological.

The question of human suffering and death before sin is, of course, associated with unique theological concerns because, unlike the animals, we are moral agents, the only creatures of God created in his image and accountable to him. How, then, are we to understand passages such as Gen. 2:17, Rom. 5:12 and 1 Corin. 15:21 which link death with sin? Hollinger notes: "Whatever our perspective on the theological debate, we must acknowledge that the Scriptures are clear in their linkage of sin and death."[52] But is sin linked to the death of animals or humans or both? The context of these passages is clearly *human* death. These verses give no support to the idea that animal death is the consequence of human sin. Further, many Christians understand these passages to be referring to spiritual death, not physical death.[53] God tells Adam that "in the day that you eat of it, you shall surely die" (Gen. 2:17, NKJV). Adam dies spiritually that day but not physically. Colossians 3:3 and 1 John 3:14 speak of the *death* of people who are physically *alive*. These passages are surely speaking of spiritual death. The words used for "death" and "die" in the latter two passages are also used in 1 Corin. 15:21, 22 to refer to

the *death* that comes as a result of sin. Furthermore, when verses such as Rom. 5:17, 18 and 1 Corin. 15:22 speak of "life" or being "made alive," the meaning is clearly spiritual life because all recipients of this "life" are physically alive but will one day experience physical death. The Bible teaches that sin causes spiritual death. It also teaches that faith in God brings eternal life. The pathway leading from spiritual death to eternal life passes through the experience of physical death. There is good reason to believe it has always been that way.

Conclusions

An old-earth position accepting of death and suffering before human sin is theologically compatible with accepted approaches to biblical interpretation. The integrative model presented in this paper is self-consistent, preserves doctrines, helps clarify what is important, allows us to better understand the kinds of questions to ask of the Bible, accords with the biblical record, and removes the conflict with science. It is incompatible, of course, with the recent creationist approach where, too often, it is a particular interpretation which is viewed as infallible rather than the Bible. Their viewpoint should not go unchallenged.

> All Christians have a stake in the successes and failures of the Creationists [recent], who cannot be allowed to hold the field as if they express the only Christian position. The primary concern is that they will ultimately fail because they reject not just the theory of evolution, but solid evidence from geology, biology, physics and astronomy as well. They do an injustice to God by rejecting the physical evidence of his universe when it conflicts with their interpretation of the Bible.[54]

Many Christians will still continue to shy away from anything other than traditional straightforward historical interpretations out of fear that not doing so will open the door to a slippery slope leading to the denial of key doctrines such as the resurrection. But there is no single approach to biblical interpretation. Hummel, when asked if he takes the Bible literally, responds by saying:

> One should take the literal parts literally and the figurative parts figuratively, aware that the biblical writers use a variety of literary forms to convey God's truth.[55]
>
> Adoption of a basically non-literal interpretive approach, coupled with a recognition that it is not the function of Scripture to teach scientific and historical facts as such, need not lead to any significant diminution of the religious instruction received from Genesis 1–11.[56]

On the other hand, the Bible does present historical belief of certain events as essential to the faith. The empty tomb and the post resurrection appearances established without doubt that Christ had conquered death and "vindicated his claim to be both Israel's Messiah and the divine Lord from Heaven."[57] Different types of literature demand different approaches to interpretation.

Some Christians will maintain that we should just accept traditional interpretations regardless of what science says. Should we then still teach a geocentric cosmology with a solid firmament[58] holding the stars and a creation date of 4004 BC? To a Christian who holds that "all truth is God's truth," this is simply unacceptable. What obstacles to belief would this "head in the sand" approach present to the world. Rethinking traditional interpretations focuses attention on the relative importance of non-biblical information in biblical interpretation. Commenting on the relationship between extra biblical information and the Bible, Young commends interpreters who support

> "the principle that extra biblical information should serve as a check to constrain the interpreter from indulging in exegeses that can no longer be credibly sustained and as a stimulus to intensified probing of the text in order to elucidate an interpretation that is faithful to the text. Indeed, ... extra biblical evidence provides a marvelous opportunity for achieving an improved understanding of the Word of God."[59]

Teachers in contact with Christian students should encourage them to pursue training and careers in all fields of science. Rather than perceiving certain scientific disciplines as enemies of the faith, more Christians should be at the forefront of knowledge in paleontology, geology, astronomy, and other fields that have bearing on origins. Why leave the challenge and excitement of discovering truth about the creation to the secular community. As Young says:

> What marvelous insights into Scripture might await the church if from now on the theologians and exegetes would work side by side with biologists, archeologists, anthropologists, geologists, linguists, astronomers, sociologists, and paleontologists! In a world of burgeoning knowledge about ancient literature, languages, civilizations, culture, and customs as well as about the workings of God's creation, biblical scholars must engage in dialogue with other representatives of the intellectual world they profess to want to influence with the good news [of the Gospel] ...[60]

And why should this dialogue not occur with increasing numbers of Christians representing all disciplines? Let's encourage more of our students,

not to fear the conclusions of science as an attack on biblical authority, but rather to welcome the insights each discipline gives to our understanding of God's world and God's Word, and to be a participant in revealing and integrating these truths. As Noll notes: "Evangelical thinking about science is still but a shadow of what God, nature, and the Christian faith deserve."[61] ❋

Notes

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[3]K. Ham, "Adam and Ants," *Back to Genesis* (September 1991):a-c, p. c. *Back to Genesis* is a pamphlet published by the Institute for Creation Research.
[4]H. Morris, "The Wolf and the Lamb," *Back to Genesis* (September 1994):a-c, pp. b-c.
[5]D. Ratzsch, *The Battle of Beginnings* (Downers Grove, IL: InterVarsity Press, 1996), 189.
[6]M. Lodahl, *The Story of God* (Kansas City, MO: Beacon Hill Press of Kansas City, 1994), 66.
[7]A. E. McGrath, *Christian Theology: An Introduction* (Cambridge, MA: Blackwell Publishers, 1994), 502.
[8]B. R. Reichenbach, *Evil and a Good God* (New York: Fordham University Press, 1982), 87.
[9]Ibid., 47.
[10]A. Plantinga, "The Free Will Defense," in M. L. Peterson, ed., *The Problem of Evil* (Notre Dame, IN: University of Notre Dame Press, 1992), 118.
[11]R. Swinburne, "Natural Evil," in M. L. Peterson, ed., *The Problem of Evil* (Notre Dame, IN: University of Notre Dame Press, 1992), 304.
[12]J. Polkinghorne, *The Faith of a Physicist* (Princeton, NJ: Princeton University Press, 1994), 85.
[13]Reichenbach, *Evil and a Good God*, 101.
[14]Ibid., 117.
[15]Ibid., 103-104.
[16]C. S. Lewis, *The Problem of Pain* (New York: Macmillan Publishing Company, 1962), 33.
[17]Polkinghorne, *The Faith of a Physicist*, 85.
[18]Swinburne, *The Problem of Evil*, 314-315.
[19]Ibid., 315.
[20]Ibid., 315.
[21]J. Stambaugh, "Creation and the Curse," *Impact* 272 (February 1996): i-iv; and K. Ham, "Adam and Ants," *Back to Genesis* (September 1991): a-c.
[22]H. Ross, *Creation and Time* (Colorado Springs, CO: NavPress, 1994), 66.
[23]H. Blocher, *In the Beginning* (Downers Grove, IL: InterVarsity Press, 1984), 184.
[24]J. Diamond, "The Golden Age That Never Was," *Discover* (December 1988): 70-79; and J. Perlin, *A Forest Journey* (Cambridge, MA: Harvard University Press, 1989).
[25]K. Ham, "Adam and Ants," *Back to Genesis* (September 1991): a-c.
[26]J. Stambaugh, "Death Before Sin?" *Impact* 191 (May 1989): i-iv, p. iv.
[27]H. Morris, "The Tree of Life," *Back to Genesis* (October 1998): a-c.
[28]Ross, *Creation and Time*, 64.
[29]J. K. Grider, *A Wesleyan-Holiness Theology* (Kansas City, MO: Beacon Hill Press of Kansas City, 1994), 323.
[30]R. Keeley, ed., *Eerdmans' Handbook to Christian Belief* (Grand Rapids, MI: Eerdmans Publishing Co., 1982), 463.
[31]Lodahl, *The Story of God*, 158-9.
[32]H. R. Dunning, *Grace, Faith, and Holiness* (Kansas City, MO: Beacon Hill Press of Kansas City, 1988); Grider, *A Wesleyan-Holiness Theology*; and A. F. Johnson, & R. E. Webber, *What Christians Believe: A Biblical and Historical Summary* (Grand Rapids, MI: Zondervan Publishing House, 1993).
[33]Dunning, *Grace, Faith, and Holiness*, 336-7.
[34]Grider, *A Wesleyan-Holiness Theology*, 328.
[35]L. Morris, *The Atonement* (Downers Grove, IL: InterVarsity Press, 1983), 201.
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[39] H. R. Dunning, *Grace, Faith, and Holiness*, (Kansas City, MO: Beacon Hill Press of Kansas City, 1988), 375; and Taylor, *Jesus and His Sacrifice*, 50.
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[42]H. Morris, "Old-earth Creationism," *Back to Genesis* (April 1997): a-c, p. b.
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[44]Ratzsch, *The Battle of Beginnings*, 189-90.
[45]Ibid., 190.
[46]Ross, *Creation and Time*, 88.
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[55]Hummel, *The Galileo Connection*, 171.
[56]Johnson, *Genesis, Geology and Catastrophism*, 134.
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[58]C. Westermann, *Genesis 1-11* (Minneapolis, MN: Augsburg Publishing House, 1984), 76.
[59]D. A. Young, *The Biblical Flood* (Grand Rapids, MI: Eerdmans Publishing Company, 1995), 305.
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[61]M. A. Noll, *The Scandal of the Evangelical Mind* (Grand Rapids, MI: Eerdmans Publishing Company, 1994), 233.

Viral Evolution: Climbing Mount Molehill?

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Richard Dawkins' defense of Darwinism, which he describes as a climb up the "backside of 'Mount Improbable'," is challenged by direct observations of the evolution of RNA viruses, whose mutation rates are a million times faster than that of other organisms. These studies suggest severe limitations to gradualism, or "descent with modification" that Dawkins insists is an essentially complete explanation of origins. Comparisons of the genomes and biochemical machinery of viruses, as well as those of simple single-celled organisms, suggest that numerous lateral transfers of genetic material, or other non-Darwinian "saltations," are needed for a naturalistic explanation of origins.

Richard Dawkins and "Mount Improbable"

The most articulate defender of Darwinism in modern times is undoubtedly Richard Dawkins, the Charles Simonyi Professor of Public Understanding of Science at Oxford University. His most important books are *The Blind Watchmaker*[1] and *Climbing Mount Improbable*,[2] which elegantly articulate the case for gradual, Darwinian evolution of even the most intricate of nature's wonders, such as the human eye or the web-spinning ability of spiders.

These examples are illuminated by engaging allegories, such as that of "Mount Improbable." On the front face of Mount Improbable is a sheer vertical cliff, impossible to climb, but on its back are "gently inclined grassy meadows, graded steadily and easily towards the distant uplands."[3] The allegory represents his belief that miracles of biological "design" and "perfection" were achieved by a slow accumulation of small changes along a path of "continuous evolutionary gradation—a smooth incline up the mountain ..."[4] The long march up this incline has transformed organisms with no eyes at all into ones containing superbly functional camera eyes, such as our own. It has also transformed primitive self-replicating molecules of the primeval "soup" into bacteria, multi-cellular organisms, and human beings.

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This theory of biological change is none other than that of Charles Darwin, who argued that the processes producing all biological variation are occurring daily. These processes are random mutations combined with natural selection, the tendency of organisms whose biological endowment is ever so slightly better suited for survival than that of their parents to displace organisms less well-suited. In time, this gradual, but inexorable, process has produced the entire panoply of life, in all its resplendent complexity. Gradualism is the key to Darwinism. Darwin said it himself: "If it could be demonstrated that any complex organ existed which could not possibly have been formed by numerous, successive, slight modifications, my theory would absolutely break down."[5] Dawkins echos this key point as he discusses Darwinism: "There can be no sudden leaps upward—no precipitous increases in ordered complexity."[6] That is, all biological change occurs by "descent with modification."

Dawkins applies Darwin's theory to the evolution of the human eye by expressing the theory as a series of simple queries. First he asks: "Could the human eye have arisen directly from something slightly different from itself, something that we may call X?"[7] Given that the difference is slight enough, the answer Dawkins and most of us would give is "yes."

The next question follows: "Is there a continuous series of Xs connecting the modern human eye to a state with no eye at all?"[8] This would seem to be just a multiplication of the first question. Dawkins says: "The answer has to be yes, provided only that we allow ourselves a sufficiently large series of Xs ... Given, say, a hundred million Xs, we should be able to construct a plausible series of tiny gradations linking a human eye to just about anything!"[9]

Then comes the third question: "Considering each member of the series of hypothetical Xs connecting the human eye to no eye at all, is it plausible that every one of them was made available by random mutation of its predecessor?"[10] He answers: "My feeling is that, provided the difference between neighbouring intermediates in our series leading to the eye is sufficiently small, the necessary mutations are almost bound to be forthcoming."[11]

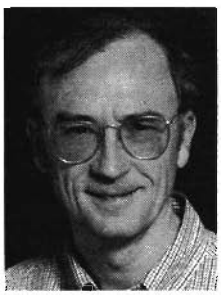
Finally, the last question is: "Considering each member of the series of Xs connecting the human eye to no eye at all, is it plausible that every one of them worked sufficiently well that it assisted the survival and reproduction of the animals concerned?"[12] Here is where many might answer "no." "What good is 5 per cent of an eye?" some ask. Or, considering the evolution of animal mimicry, wherein, e.g., an insect evades predators by looking uncannily like a twig, or, in another case, like a piece of dung, a scoffer may ask: "Can there be any edge in looking 5 per cent like a turd?" Dawkins does not flinch. He answers:

> If I ... am walking through a forest at dusk, I may well fail to distinguish almost any dull-coloured insect from the twigs that abound everywhere. The image of the insect may pass over the edge of my retina rather than the more acute central region. The insect may be 50 yards away, and so make only a tiny image on my retina. The light may be so poor that I can hardly see anything at all anyway. The important thing about light intensity, distance of insect from predator, ... and similar variables, is that they are all continuous variables ... Such continuous variables foster continuous and gradual evolution.[13]

Dawkins rams home this point by drawing on his vast knowledge of biological diversity. His discussion of variations of the eye is particularly telling:

> Some single-celled animals have a light-sensitive spot with a little pigment screen behind it. Among many-celled animals, various types of worm and some shellfish have a similar arrangement, but the pigment-backed light-sensitive cells are set in a little cup. This gives slightly better direction–finding capability ... In a continuous series from flat sheet of light-sensitive cells, through shallow cup to deep cup, each step in the series, however small the step, would be an optical improvement. Now if you make a cup very deep and turn the sides over, you eventually make a lensless pinhole camera ... The swimming mollusc Nautilus ... has a pair of pinhole cameras for eyes ... When you have a cup for an eye, almost any vaguely convex, vaguely transparent or even translucent material over its opening will constitute an improvement, because of its slight lens-like properties ...[14]

Dawkins expands upon this explanation in his book, *Climbing Mount Improbable*, wherein the reader is taken on an excursion through the wide world of eyes: the cup eyes of the flatworm, the pinhole eyes of the Nautilus, the compound eye of the dragonfly, the "fibre-optic eye" of deep-sea crustaceans, the camera eye of humans, and others. By examining the distribution of eyes in the animal kingdom, it has been deduced that "eyes have evolved no fewer than forty times"; they seem to evolve at the "drop of a hat."[15] In a computer model of eye evolution, Nilsson and Pelger started from a flat layer of photocells that could "evolve" randomly by small steps to permit both curvature and index of refraction variations to accumulate. Granting only a slightly higher survival probability to each slight improvement in the "eye," in only 364,000 generations, there appeared a computer version of a "good fish eye with a lens."[16]



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Darwinism by Design

Dawkins provides an easy-to-understand computer simulation of the principle of selection from random mutations using the example of a "monkey typist." The monkey's first efforts on the typewriter produce the following random string of characters:

WDLMNLT DTJBKWIRZREZLMQCO P

Dawkins now "breeds" from this incomprehensible starting point a litter of "progeny" in each one of which a letter is randomly changed to any other letter (with a space counting as a letter). Of all the offspring, only one is kept for continued breeding; the one whose letter sequence matches more closely, however, slightly, the Shakespearean phrase:

METHINKS IT IS LIKE A WEASEL

After forty-one generations of "breeding," the random initial phrase "evolves" into the target phrase: "METHINKS IT IS LIKE A WEASEL."[13]

This example illustrates the point that small random mutations, *if selected upon nonrandomly*, can accumulate to produce large changes. Also, in both the computer "eye" problem and the typing-monkey problem, the rate of evolution can be estimated from knowledge of the mutation rate and the specificity of the selection. The specificity of the selection, which is the degree of survival advantage gained from each small improvement, was chosen to be small in the simulation of "eye" evolution, and large in the typing-monkey problem. This explains the fast evolution of the random sentence of the typing monkeys in comparison to the computer-evolved "eye."

Dawkins has little patience with those who dismiss Darwinism as "a theory based on chance." He says Darwinism is "a theory of random mutation plus *nonrandom* cumulative natural selection."[14] To Dawkins, the mutations are not important; they are random and ever present. What is important is that there is a "selection pressure," which favors mutations that push ever so slightly in a given direction, leading to accumulated change over time.

We can illustrate "selection pressure" by the thermodynamic principle that a gas confined by a piston in a cylinder, if heated slightly, will increase its pressure and then expand by pushing the piston out of the cylinder. The process by which this occurs involves tiny molecules striking the piston almost randomly from each side. However, because of the small temperature difference, the molecules inside the cylinder strike the piston slightly more energetically than those outside. If you look at only a few collisions, or even hundreds of them, you would not notice any particular difference in the force of the impact, and any difference that you might notice would be minuscule in comparison to the force needed to move the massive piston. Nevertheless, there are fantastically many collisions, so that even a slight bias in their intensity eventually produces a large effect. Although the motion of the piston might seem rapid to us, it actually occurs very slowly compared to the velocity of the molecules. We can explain this phenomenon without having a detailed theory of the dynamics of gas molecules; we only need to know that there is a bias in their energies of impact. Likewise, Darwin confidently predicted the occurrence of large evolutionary change, although he was completely ignorant of the mechanisms of mutation upon which his theory depended.

What is important [to Dawkins] is a "selection pressure," which favors mutations that push ever so slightly in a given direction, leading to accumulated change over time.

The analogy of a sentence mutating by random changes in characters is apt in one sense at least: living things actually do have a kind of alphabet from which "sentences," "paragraphs," and whole "libraries" are constructed. The "letters" of the biological alphabet are the amino acids from which protein chains are built. Proteins make up the enzymes and other components of the machinery of life. There are twenty amino-acid "letters," rather than the twenty-seven letters of the "monkey" alphabet (counting the space as one letter). At the level of the DNA or RNA genetic code, a single amino-acid letter in the "alphabet" of life is coded for by a "codon," a triplet of three DNA bases.[15] These bases consist of nucleotides given the letters A, T, C, and G. Thus, the triplet TAC codes for the amino acid tyrosine, which is given the letter "Y," while TTT represents the amino acid phenylalanine, which is given the letter "F." Since there are $4^3 = 64$ different triplets that can be formed from the four-letter alphabet of the genome, while there are only twenty amino acids to be coded for, the genetic code has some redundancy. For example, the amino acid phenylalanine is coded for by both TTT and TTC.

Small changes in genetic information occur by mutations in the coding triplet. For example, a single

copying error might change TAC to TTC, which would change the amino acid "Y" (tyrosine) into "F" (phenylalanine) in the protein synthesized by the cell. Such errors or "mutations" are known to occur, and their frequency has been measured. Such a mutation might produce no change in the functioning of the protein, a degradation in its functioning, or, much more rarely, a slight improvement in its functioning.

The rapid mutation rate [of RNA viruses] implies that they could in principle refresh their entire genome in several thousand generations, which, thanks to their short reproductive cycle time, is no more than a few years!

Fortunately, we know the time available for evolution, and the rate of mutation has been measured for various species. For eukaryotic life forms (those containing a cell nucleus), which include nonbacterial organisms ranging from yeast to humans, the mutation rate M is around 10^{-8} to 10^{-11} mutations per base pair per cellular replication cycle.[16] (For complex multi-cellular organisms, the cellular replication time might be significantly less than that for replication of the entire organism.) Therefore, for eukaryotes, in particular multi-cellular ones, we can crudely estimate the cellular reproduction rate to be in the order of one year. Thus, a mutation rate of, e.g., 10^{-9} would imply that the organism could by random mutation refresh its entire genome in around 10^9 (or one billion) years, a period of time that corresponds nicely with the actual period of time available. (The age of the earth has been repeatedly measured at around 4.5 billion years.)

Thus, from this standpoint, the "Blind Watchmaker" hypothesis is reasonable. In fact, assuming a uniform rate of mutation, the genetic differences among organisms are sometimes used to estimate the approximate time period that has elapsed since two organisms diverged from their most recent common ancestor. This controversial dating method is based on the assumption of a molecular or genetic "clock" that ticks off mutations at a constant rate. (It is now known that different genetic "clocks" tick at very different rates, and perhaps at rates that vary with time, a finding that greatly complicates the use of such "clocks."[17])

However, to demonstrate empirically the truth of the "Blind Watchmaker" hypothesis, without having to resort to fictitious computer models, such as those for a "fish eye," or for the "typing monkeys," we need to examine a real biological system over a duration of time long enough to observe its steady evolution from one type of form of life into a radically different one. The time T required for an organism to completely refresh its genome is the cellular reproductive cycle time R, divided by the mutation rate M; that is, $T = R/M$. As noted above, however, this time T is in the order of a hundred million to a billion years for complex multicellular life forms. For simpler life forms like bacteria, the reproductive cycle time R can be reduced to a day or less, but, even so, T remains in the range of millions of years. For a human, a mutation in a single gene containing, e.g., 1000 bases, might take thousands of generations. Therefore, Dawkins justifies the use of crude computer models to back up his evolutionary arguments. He says: "Humans haven't the patience to wait a million generations for a mutation!"[18]

Viral Evolution: A Modest Proposal for the "Blind Watchmaker"

Amazingly, however, there exist microbes for which the time T is experimentally accessible! These are the RNA viruses. A virus is an entity that is simpler than the simplest free living cell. It cannot generate energy or reproduce on its own; it reproduces by infecting a living cell and hijacking that cell's reproductive machinery, forcing it to manufacture viral components, rather than those of the cell. In addition to their short reproduction time (a few hours or less), RNA viruses have an extraordinarily high mutation rate M, around 10^{-3} to 10^{-5}![19] The reason for the high mutation rate is that the elaborate error-checking and repairing mechanisms that cells and DNA viruses employ during the replication of DNA do not operate in the replication of RNA. The high error rate in RNA replication may actually be beneficial to the RNA virus, since it can then mutate and evolve rapidly in response to attacks by the organism's immune system, or by anti-viral drugs administered to combat the virus. RNA viruses, such as the influenza virus, are notorious for their agility in evolving resistance to vaccines and anti-viral drugs. Dimmock and Primrose say: "An RNA virus can achieve in one generation the degree of genetic variation which would take an equivalent DNA genome 300,000 generations to achieve."[20]

For purposes of studying evolution, therefore, RNA viruses are ideal. Their rapid mutation rate implies that they could in principle refresh their entire genome in several thousand generations,

which, thanks to their short reproductive cycle time, is no more than a few years! In addition, RNA viruses have genomes of modest size. In some cases, only around ten thousand bases, or "letters" of the genetic code, are enough to specify the entire virus. While this many letters might be analogous to, e.g., a whole chapter of reading material, it is a far cry from the whole library of genetic material present in the three-billion-base genome of a human. Thus, comparisons of the evolutionary family tree of viruses should be readily possible at a level of detail that extends down to that of individual bases. One might even hope eventually to reproduce biochemically the "stepping stones" by which virus "A" might have evolved into a completely different virus "B" by creating in the laboratory "missing-link" viruses that have attributes intermediate to those of "A" and "B." Thus, viral evolution is an area ripe for testing evolutionary hypotheses. Domingo and Holland, for example, note:

> Limited complexity of genomes ..., their high mutability, rapid replication rate, and the possibility of testing the effects of several millions-fold differences in the population numbers of replicating genomes, confer great value upon viruses as model systems for understanding molecular evolution.[21]

While work on RNA viral evolution is in its infancy, early work has already yielded results that bear directly on the "Blind Watchmaker" hypothesis. Remember that, as stated by Dawkins, this hypothesis asserts that when a self-replicating system faces a fitness hurdle to its survivability, it will evolve novel and unanticipated functions. In the case of RNA viruses, experimental versions of the monkeys with typewriters have recently been realized. In these experiments, viruses are allowed to reproduce in a cellular culture; progeny viruses are harvested, and a randomly-chosen fraction of the resulting viruses are then used to infect a fresh cellular culture. Changes in the "fitness" of a viral population from generation to generation are directly measured by its infectiousness (that is, the number of progeny produced) relative to a reference virus grown under the same conditions.[22]

What do these experiments show? They show that, starting from an initial "wild-type" virus, viral fitness improves from generation to generation in just the way Darwin predicted. Fig. 1 shows that the fitness of vesicular stomatitis virus (VSV) improves exponentially (that is, linearly on a semi-log plot) during multiple passages through a cell culture, up to around one hundred passages. Thus, ten-fold improvements in fitness can actually be observed in the laboratory, thanks to the fast reproduction and high mutation rate of RNA viruses.[23]

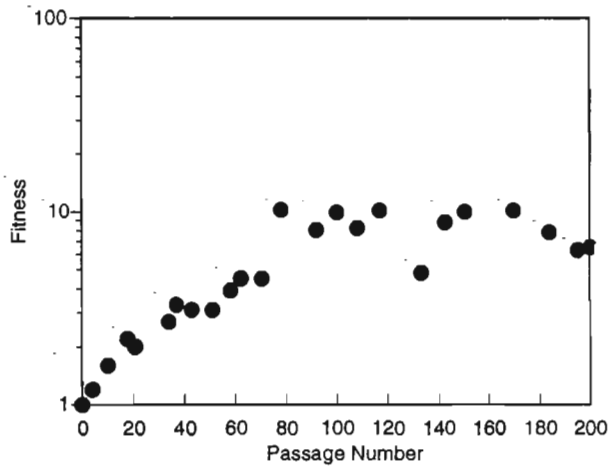

Fig. 1: Fitness gains of vesicular stomatitis virus (VSV) as a function of passage number in BHK-21 cells (data from Novella, et al.[24]).

While some viruses improve their fitness, as we observe in Fig. 1, others actually become less fit over time.[25] How could this happen? The experiments in which the fitness decreases with time are ones in which only a few, or even one virus particle is taken from a reproducing colony to form the ancestry of the next-generation colony. This highly constricted survival rate is imposed to mimic the effect of viral transmission from one host to another, which might occur by way of only a few, or even only a single viral particle.[26] The reason that fitness can decrease under such constrained conditions of reproduction is now understood. It is due to the overwhelmingly high ratio of unfavorable mutations to favorable ones. When the viral colony faces a mass slaughter that leaves, e.g., only a single survivor, then the rare superior virus present in the colony is most likely to have been cut down along with the rest. Thus, the single virus that remains to produce offspring owes its survival, not to superior genes, but to luck. In all probability, the survivor will be an inferior representative of his formerly numerous colony. In this case, the following proverb holds good:

> *"The race is not to the swift;*
> *nor the battle to the strong ...*
> *but time and chance happeneth to them all"*
> —(Eccles. 9:11).

This phenomenon, whereby a colony of organisms loses fitness due to "bottlenecks," or constrictions in the number of surviving descendants, is known as "Muller's Ratchet."[27] The rare superior virus can break the ratchet only in prosperous times, during which it can combine ample resources with its superior growth and reproductive

capabilities to gradually outproduce and overwhelm the vast hordes of inferior rivals.

Figure 1 shows the development of viral fitness under "prosperous" conditions in which VSV particles were transferred from one culture to the next. As we noted, fitness improves exponentially for around one hundred passages. After that, fitness levels off, and no steady gains in fitness are observed, only fluctuations in fitness. These recent results show that even under favorable conditions there is an apparent limit to viral fitness, at least within a given host medium over the duration of time tested. Thus, time plus the availability of mutations is not by itself a sufficient condition for continuous evolution.

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Although these experiments are limited in their numbers of reproductive cycles, their results are consistent with other observations. The range of mutations actually permitted to a given virus has been observed to be limited, over the time scale for which direct observations are made (which, as noted, is as long or longer than the time T required to "refresh" the genome). Thus, experiments with picornaviruses (a class that includes the common cold) show frequent recurrence of the same subsets of mutations. Domingo and Holland note:

> Even during several decades of viral evolution, variable positions in the capsid [coat] proteins of picornaviruses are alternatively occupied by a small subset of all possible amino acids, and a true accumulation of amino acid substitutions is not observed.[28]

Many virus codons and the corresponding amino acids are highly conserved. These include regions of the RNA associated with gene regulation, and even some receptor recognition sites where the virus is sensitive to antibody attack.[29] Mutations at these and other positions on the RNA strand are not tolerated. As a result, the range of genetic variation available to each viral type is narrow. Beyond a certain number of replication cycles, the drift of the viral genome becomes limited as the virus explores new territory less frequently and instead revisits its old haunts again and again.

What can we make of reports of the emergence of "new" viruses? Periodic outbreaks of apparently new viral diseases are recurrent in human history; the AIDS epidemic is only a recent example. New strains of the influenza virus emerge episodically, including the disastrous 1918 "Spanish influenza" pandemic that killed twenty million people worldwide. However, instances in which the origins of a "new" disease have been tracked down suggest that in each case the virus responsible for the outbreak is usually not really new, but is instead a transplant from another species. For example, it now appears that new influenza strains, which frequently emerge from China, are carried from waterfowl to pigs, and then to humans. This "viral traffic" is stimulated by integrated pig-duck farming common in China.[30]

Many other examples are now available in which viral outbreaks are traced to inter-species migration of an existing virus, often because of a change in agricultural or other practices. In the case of the H2N2 influenza strain, for which an outbreak occurred in 1957, blood sera taken from people who had been alive in 1889 showed the presence of these same H2N2 antibodies, demonstrating that this "new" virus had merely been "hibernating," perhaps in an animal vector. After the earlier, resistant population had largely been replaced by a vulnerable younger population, H2N2 was able to re-emerge with renewed virulence. Morse summarizes: "Over the period of recorded history, emerging viruses have usually not been newly evolved viruses. Rather, they are existing viruses conquering new territory."[31]

Thus, large changes in viruses seem to require mechanisms other than the accumulation of single-base "point" mutations, the kind represented by the typing monkeys. One such additional mechanism might be the evolution of the host cell. This might provide a change in viral environment, and open up the range of permitted mutations in a new direction. Another possibility is genetic re-assortment or recombination. The genome of influenza A virus, e.g., consists of eight single-strand RNA segments, each coding for one or two proteins. If a cell is simultaneously infected with two strains of this virus, the RNA segments of the two are randomly assembled in the next-generation virus. These hybrid viruses are genetically stable and can be produced in both cell cultures and whole animals. A hybrid strain of influenza recently infected harbor seals off the coast of Maine, killing 20% of the population.[32]

A fascinating case in which a somewhat novel virus may have emerged through recombination is that of the Western equine encephalitis virus (WEE),

a type of togavirus. Togaviruses receive their name from the distinctive lipid bilayer these viruses wear over their protein coats like a Roman toga. After the genome of this virus was sequenced, it was found that the two glycoproteins of WEE are very similar to those of the Sindbis virus, while the portions of the genome coding for replication enzymes and the coat protein are similar to those of the Eastern equine encephalitis (EEE) virus.[33] The simplest explanation for this is that WEE arose from recombination of genetic components borrowed from both Sindbis and EEE "parents." When this may have occurred is not known precisely, but based on the sequence differences and rates of mutation for this virus, it seems to have occurred at least one hundred years ago, and maybe much earlier.[34]

However, the change produced by this apparent recombination represents a rather minor degree of evolution. WEE, EEE, and Sindbis are all alphaviruses, which are mosquito-borne members of a single genus within the family of togaviruses. All three viruses have genomes of similar size and structure that are segmented identically and replicate themselves similarly. The modular arrangement of the genomes of viruses creates many possibilities for genetic "mixing and matching," whereby modular genetic units are swapped. Thus, when gene re-assortment occurs (which can be very rare or perhaps nonexistent in some viruses),[35] it usually produces relatively minor changes, at least when compared to the changes required for the appearance of altogether new viral forms.

In fact, there is an enormous diversity of viral forms. Viruses differ one from another in their genetic material (RNA vs. DNA, double stranded vs. single stranded), in their shape (cylindrical, spherical, head-tail), in their mode of entry into the cell, in their biochemistry of replication, in the presence or absence of a lipid envelope, and in other important ways. Even allowing for genetic re-assortment and environmental change, in most cases, it is difficult to visualize how one class of viruses could have given rise to a different one by a process of gradual change. Thus, a transition from one class to another, if it occurred, would seem to have occurred in one sudden jerk, or "saltation,"[36] an occurrence explicitly rejected by Darwin and Dawkins (although Dawkins allows the possibility of saltations in rare cases, such as the origin of life).[37]

The possibilities for gradual evolution of viral shape are also restricted, but for somewhat more subtle reasons. A coding triplet of DNA or RNA has a molecular mass of around one thousand Daltons, while the amino acid it codes for has an average mass of only one hundred. Since the mass densities of proteins and nucleic acids are roughly the same, the genetic coding of a given volume of protein requires a ten-fold greater volume of nucleic acid (RNA or DNA). However, because of the tiny size of viral particles, and the requirement of complete encapsulation by protein, viral particles typically contain at least as much protein as nucleic acid. Thus, the interior volume of the viral protein shell does not suffice to hold the volume of DNA or RNA required to code for the entire shell! The virus escapes this "volume paradox" by inducing the host cell to make many copies of only one or a few small coat proteins which can link together like in a suit of mail, to completely coat the virus; see Fig. 2.

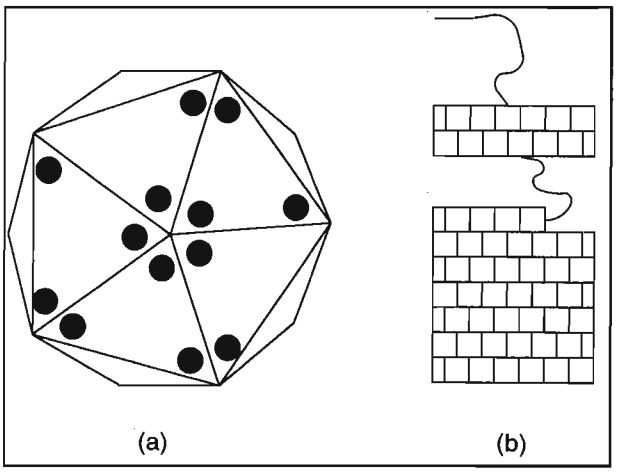

Fig. 2: Viral coat geometries. (a) An icosahedral coat built from sixty identical proteins, three per face, represented by solid circles. (b) A cylindrical coat built from identical proteins, represented by "bricks." The process of self-assembly of the coat with the simultaneous enclosure of single-stranded RNA is also depicted (adapted from Dimmock and Primrose[38]).

Since individual protein molecules are irregular three-dimensional objects, self-assembly of these into a thermodynamically stable coat imposes certain symmetry requirements on the geometric form the coat can take. Thus, highly symmetric shapes, such as rods, or spherically symmetric "Platonic solids," especially the twenty-sided icosahedron, are preferred. See Fig. 2. A gradual evolutionary transition from one such specialized shape to another thus seems improbable, since intermediate shapes would lack the symmetry of these discrete simple choices, and would therefore fall prey to the "volume paradox." Although recombination events might allow some of the nonshape-coding genetic material from a virus of one shape (e.g., an icosahedron) to be incorporated into the genome of a virus of a different shape (e.g., a rod), it is hard to see how the genetic

"modules" that code for shape can themselves change so that one shape is replaced gradually by another different shape. Of course, the protein itself might mutate gradually, but the most stable shape into which the protein self assembles should change discretely and abruptly. Thus, finely-sliced Darwinian evolution of shape is precluded, at least for the smaller viral particles that are constrained by the "volume paradox." This example contradicts Dawkins' claim that small changes in the shape or functioning of an organism are always available to it via small mutations. (In more complex organisms, it is also easy to find examples of changes which cannot be sub-divided into Dawkinsonian "continuous variables." An obvious example is the number of chromosomes, which must be an integral number and differs, e.g., between humans and apes.)

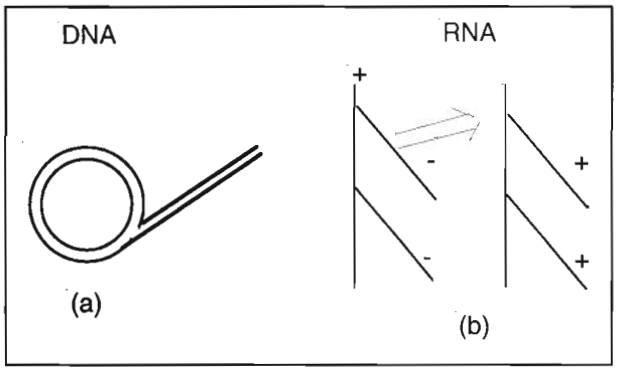

Fig. 3. Mechanisms of viral replication. In (a), a "rolling circle" of double-stranded DNA is replicated to produce a double-stranded DNA copy. In (b), "+"-strand single-stranded RNA (which has the same sense as messenger RNA) is the template for synthesis of "-"-strand RNA, which in turn is the template for production of "+" RNA. This "+" RNA is then enclosed in the viral coat protein to form a new virus particle (adapted from Dimmock and Primrose).[39]

Much more difficult problems attend any transition from one mode of viral replication to another. In one type (Baltimore class IV), the viral genome possesses a single "positive" strand of RNA which must produce its complimentary "negative" strand before messenger RNA is produced to direct protein synthesis. In another type (Baltimore class V), the initial RNA strand is "negative" and can directly induce messenger RNA production. Other RNA viruses (class III) carry double-stranded RNA and reproduce in yet different ways. Finally, RNA retroviruses (class VI) catalyze DNA production via a special enzyme, "reverse transcriptase." Examples of class IV viruses include the common-cold virus, class V include the influenza virus, and class VI the AIDS (HIV) virus. Then there are the single and double-stranded DNA viruses, with yet different reproductive mechanisms.

Figure 3a illustrates the reproductive mechanism of lambda-phage, a class I virus which reproduces its double-stranded DNA directly via a "rolling circle" mechanism. This is entirely different from the replication mechanism of class IV viruses that use the infecting single-strand RNA+ as a template to produce RNA-, which then serves as a template for RNA+ to be packaged in new viruses. See Fig. 3b. The topological structures of these synthetic pathways are inherently distinct, and the steps in each pathway are few. Hence, a change in the pathway would need to take place by discreet additions or subtractions of pathway steps. And, since the product of one step is the RNA, DNA, or protein needed for the next step in the pathway, the disappearance or replacement of one step would certainly have to be accompanied by other simultaneous changes to maintain continuity of the production cycle. Thus, while the rate at which a single step in the pathway is carried out might vary as a result of small mutations, complete removal or insertion of a step in the pathway is an intrinsically large evolutionary step that cannot be broken down into a series of smaller ones. The Darwinian requirement of "gradual, continuous improvement" (or descent with modification) would not seem to be available.

Therefore, each viral type (selected, e.g., from Baltimore classes I through VI) has a fundamentally different reproduction strategy. A gradual shift from one viral type to another by way of accumulated point mutations, or even re-assortments, is hard to imagine. Rather, the collection of all possible viral forms appears to be a set of discrete points in configurational space and not a continuum of possibilities. If so, evolution from one state to the next would have to occur by "saltation," that is, large hops, rather than by the slow, gradual transitions envisioned by Darwin and Dawkins.

Recognizing these difficulties, virologists have speculated that some viral types originated completely independently of each other. In one scenario, viruses are genetic components that escaped from a cell.[40] In this view, each different viral type is the offspring of the cell type that it now infects. Another scenario holds that viruses are the end result of the degeneration of free-living cells. One might also speculate that viruses arose during the "primordial" period of molecular evolution, which is presumed to have preceded the emergence of cellular life. In this third scenario, as biochemical networks became organized into enclosed communities or cells, the portions of the network rejected by the cells became "outlaws," surviving by attacking and ransacking the cells from which they were excluded. One might also speculate that viral particles originated from

cancerous cells. Cells become cancerous when their regulatory control breaks down, leading to runaway reaction networks. A self-sustaining reaction network compact enough to become independent of the cell from which it originated might become a virus, if the network is able also to produce a suitable protective protein coat.

While such scenarios make for interesting speculation, they stand outside the boundaries of hard, empirical science. For example, while it is true that some viruses, such as hepadnaviruses, can produce cancer,[41] this does not mean that the reverse has ever occurred. Furthermore, whichever scenario one might favor, each constitutes non-Darwinian evolution; that is, evolution not by small changes as Darwin envisioned, but by "saltation," that is, large changes whose occurrence is far from commonplace, very unlike the small mutations upon which Darwinism rests. Thus, even in the most favorable of circumstances of the high-speed mutations and short reproductive cycle of RNA viruses, scientific demonstration of the evolutionary radiation of different viral strains from a single progenitor seems to be beyond the reach of known empirical science. Appearance of new viral forms seems to depend on highly fortuitous circumstances, odd twists of nature, and freakish events that are both unpredictable and impossible to reconstruct with any confidence.

The Tree or the Briar Patch?

Nor do these conclusions apply to viruses only. Recent genomic sequencing shows that the simplest bacterial life forms that are considered to be near the base of the tree of life have genomes that are incompatible with the simple "descent-with-modification" formula of Darwin and Dawkins. In Darwinism, family relationships among organisms must be that of a genealogical tree – that is, a branching structure. This point is emphasized forcefully by Dawkins:

> It follows from the idea of evolution that there is one uniquely correct branching family tree of all living things, ... [which] has the property of perfect nesting. We write the names of any set of animals on a large sheet of paper and draw rings round related sets ... Never, not on a single solitary occasion, will the rings that we draw intersect each other.[42]

Yet, near the base of the tree of life, it is now known that the rings do intersect each other.

Life at its most basic is currently divided into three kingdoms: *eukaryotes*, simple *bacteria*, and "*archaea*." (Archaea are known for living in extreme environments, such as boiling-hot, deep-sea thermal vents.) The relationships among single-celled organisms in these three different kingdoms of life must be graphed as a network, rather than a tree. Thus, e.g., eukaryotic cells have large numbers of informational genes that are closely related to archaea, while the operational genes are more closely related to those of bacteria.[43] Since bacteria and archaea are traditionally regarded as more ancient than the more advanced eukaryotic cells, the presence of some genes in eukaryotes that are unique to bacteria, and other genes that are unique to archaea, could only mean that the eukaryotes are "chimeric" – that is, a fusion of two earlier life forms! Extensive study of the genomes of these simple organisms are thus not consistent with Darwinian descent, but instead can only be explained by postulating the repeated transfer of whole genes and even large clusters of genes from organism to organism. To account for the genome of the bacterium E. Coli, e.g., one must postulate that no fewer than 755 of its genes have been transferred to it in at least 230 "lateral" transfers from other organisms.[44] Thus, "gene swapping" may have "turned the tree of life into a tangled briar whose lineages may be next to impossible to discern," says Pennisi in a 1999 *Science* article entitled "Is it time to uproot the tree of life?"[45]

One might be tempted to relegate such non-Darwinian processes to the simplest of life forms, such as viruses, bacteria, archaea, and the like. However, the explosion in genetic information is also turning up similar examples in higher organisms. Dawkins himself notes one example. The gene for hemoglobin (a key protein in the red blood cells of higher animals) has been found to exist in plants of the pea family, and hemoglobin itself exists in the roots of this plant! Hemoglobin has not been found in any other plant families, and so could not have been passed down to this species by "descent with modification." Instead, it must have been transferred to the pea plant directly from an animal, perhaps by a viral carrier. With the rapid sequencing of genomes, many more genes are turning up in "the wrong place." For example, the bacterium, Deinococcus radiodurans, contains several genes found up to now only in plants. Another bacterium, mycobacterium tuberculosis, contains at least eight human genes.[46]

Furthermore, there are many examples of "convergent evolution," in which animals in remote families of life are uncannily similar to each other in many respects. An example is the Australian marsupial "mole," which, except for its pouch, is almost indistinguishable from an ordinary placental mole. Other examples include a marsupial "saber-toothed tiger" and a marsupial "anteater," each very similar to its evolutionary, remote placental counterpart. As

long as these similarities are purely external, one can explain them (as Dawkins does) as the result of a similar selection pressure acting on initially very different organisms, leading them to acquire similar traits.[47] One such trait is the eye, which Dawkins believes evolved on at least forty separate occasions.

Recent genomic sequencing shows that the simplest bacterial life forms that are considered to be near the base of the tree of life have genomes that are incompatible with the simple "descent-with-modification" formula of Darwin and Dawkins.

Much harder to explain, however, are extreme similarities in the biochemical machinery adopted by diverse organisms as they shape themselves to their environment. In the case of the eye, e.g., it has now been found that the gene that triggers its formation in the embryos of animals as diverse as insects and mice is almost identical! This gene is called "eyeless" because its deletion from the genome of an organism results in failure of that organism to produce eyes during embryonic development.[48] However, the presumed Darwinian structure of the "tree of life," and the absence of eyes in some of the species that are considered evolutionary links between species with eyes, implies that eye formation in these separate organisms occurred independently! Thus, the "random" mutations that led on multiple separate occasions to eye formation appear to have repeatedly recruited the same gene "eyeless" to trigger eye formation. What would have happened had this particular gene never been invented by evolution? Darwin and Dawkins say that nature is resourceful; some other gene could equally well have been mutated to form eyes. But the evidence strongly suggests that paths to the eye that do not involve the "eyeless" gene are rare or nonexistent; otherwise nature would not have gone back repeatedly to the same gene to initiate eye formation.

A similar story has recently emerged regarding the evolution of "cryptochromes," which are photoreceptor proteins in plants and animals.[49] As in the case of "eyeless," the same evolutionary pathway seems to have been followed repeatedly, even at the biomolecular level, contradicting Dawkins' statement that "it is vanishingly improbable that exactly the same evolutionary pathway should ever be travelled twice."[50] The specificity of the evolutionary steps required for these transformations calls into question Dawkins' assertion that the mutations necessary for evolution were "bound to be forthcoming." Rather, instead of evolving gradually by trial-and-error "invention," organisms seem to have resorted to "espionage," stealing heavily from each other across vast distances in the family "tree."

The analogy of monkeys with typewriters, therefore, is not an apt metaphor for evolution. Rather, one must suppose that the monkeys are stealing whole pages from each other's typewriters. In such a version of evolution, Lincoln's Gettysburg address would be produced not by an accumulation of small typing errors, but by random splicing together of the *Magna Carta* and *Beowulf*.

Philosophies

Of course, this is just what many believe happened. That is, "mix-and-match" transfer of large chunks of genetic material from one organism to another is increasingly thought of as a vital part of the evolutionary process. It remains to be seen how much of evolution must be accounted for by non-Darwinian "borrowing," as more and more genomes are sequenced. Of course, "non-Darwinian" does not necessarily imply "improbable," let alone "miraculous." Broadly speaking, one can look on the question of origins in one of five ways, allowing for gradations within and between each way.

1. **Darwinian Evolution:** Accumulation of small mutations by natural selection. The pace of evolution may vary from "slow" (little change over millions of years) to "fast" (substantial change over millions of years), as long as no large step occurs in a single generation.
2. **Random Saltation:** Major changes by large "jumps" in a single generation, either by "borrowing" genetic material from another organism, frame shifts in the genome, increase in chromosome number, etc. While these changes are very rarely favorable, enough time is available to make them probable.
3. **"Anthropic" Saltation:** As in position 2, except that the changes are so rarely favorable that large-scale evolution is unlikely to occur in any one universe. With infinite numbers of possible universes, any universe with observers (like ours) is inevitably one in which these overwhelmingly unlikely events have occurred.

4. **"Providential" Saltation:** As in position 3, except that the extremely improbable events in a single universe were foreordained and planned by God, who "engineered" them without violating physical laws, either through setting of initial conditions, exploiting of quantum uncertainty, or other, perhaps unknowable, methods.
5. **Miraculous Creation:** Transformation or creation of organisms by divine processes that supercede physical laws or principles.

Of course, "hybrid" positions combining two or more of the above are possible. Dawkins's position is 1, with some admixture of 2 to account for the origin of life. Philosophically, positions 1 through 3 are compatible with atheism, while positions 4 and 5 obviously are not. However, empirically, position 3 cannot be distinguished from position 4. Both involve events that are probabilistically impossible within a single universe. Practically, it may well be impossible (at least in the short run) to distinguish position 2 from position 3, since both involve events whose probability seems to be impossible to estimate. Likewise, "moderate" forms of position 5 may not really be distinguishable empirically from position 4, although certainly a radical creation event, such as a literal "six-day" creation, would be distinguishable from position 4. Thus, from Dawkins' point of view, one of the main appeals of evolutionary theory, namely that it renders God redundant, would be put at risk were even position 2 to be considered more likely than his own position 1. This may account for his strong attachment to the strict Darwinian position. It must be noted, however, that he honestly owns up to some limitations of this position when forced to. Therefore, it will be most interesting to watch the "evolution" of his position and that of other Darwinists, as the floodgates of genomics open.

Summary

The backside of Mount Improbable is not the "gently sloping meadow" of Dawkins' imagination. Instead, consideration of even the simplest self-replicating entities, RNA viruses, shows that even the backside is a rugged landscape filled with wide canyons and harrowing ledges. The climb up this mountain requires not merely steady walking, but fortuitous landslides to fill in the canyons, and timely earthquakes to split the ledges. Since the earth is some 4.5 billion years old, such "coincidences" cannot logically be ruled out. However, the elevation of evolutionary theories of origins from the speculative or "folk-lore" status they held before Darwin to the unquestioned acceptance that they have since been accorded is now being eroded by the advances in genomics and biochemistry. We should no longer place Darwinism as a universal theory of the origin of species alongside empirically established scientific principles such as the laws of thermodynamics. ✱

Notes

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[11] Ibid.
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[26]E. A. Duarte, I. S. Novella, S. Ledesma, D. K. Clarke, A. Moya, S. F. Elena, E. Domingo, and J. J. Holland, "Subclonal Components of Consensus Fitness in an RNA Virus Clone," *Journal of Virology* 68 (1994): 4295–301; and Domingo, et al., "Basic Concepts in RNA Virus Evolution," 859–64.

[27]H. J. Muller, "The Relation of Recombination to Mutational Advance," *Mutation Research* 1 (1964): 2–9; and Domingo, et al., "Basic Concepts in RNA Virus Evolution," 859–64.

[28]Domingo and Holland, "RNA Virus Mutations and Fitness for Survival," 165; and M. A. Martínez, J. Dopazo, J. Hernadez, M. G. Mateu, and F. Sobrino, "Evolution of the Capsid Protein Genes of Foot-and-Mouth Disease Virus: Antigenic Variation Without Accumulation of Amino Acid Substitutions over Six Decades," *Journal of Virology* 66 (1992): 3557–65.

[29]Domingo and Holland, "RNA Virus Mutations and Fitness for Survival," 151–78.

[30]S. S. Morse, "Examining the Origins of Emerging Viruses," in *Emerging Viruses*, ed. S. S. Morse (New York: Oxford University Press, 1993), 10–28.

[31]Ibid., 15.

[32]Dimmock and Primrose, *Modern Virology*, 286.

[33]C. S. Hahn, S. Lustig, E. G. Strauss, and J. H. Strauss, "Western Equine Encephalitis Virus Is a Recombinant Virus," *Proceedings of the National Academy of Sciences* 85 (1988): 5997–6001.

[34]J. H. Strauss, "Recombination in the Evolution of RNA Viruses," in *Emerging Viruses*, ed. S. S. Morse (New York: Oxford University Press, 1993), 241–51.

[35]J. P. Icenogle, P. Sathya, D. I. Miller, R. A. Tucker, and W. E. Rawls, "Nucleotide and Amino Acid Sequence Variation in the L1 and E7 Open Reading Frames of Human papillomavirus Type 6 and Type 16," *Virology* 184 (1991): 101–7; and T. C. Yamada, C. M. Wheeler, A. L. Halpern, A-C. M. Stewart, A. Hildesheim, S. A. Jenison, "Human papillomavirus Type 16 Variant Lineages in United States Populations Characterized by Nucleotide Sequence Analysis of the E6, L2, and L1 Coding Segments," *Journal of Virology* 69 (1995): 7743–53.

[36]A large step, or jump, in a single generation is known as a "saltation." Evolution by saltations is firmly rejected by both Darwin and Dawkins (with some exceptions, in the case of Dawkins). Now that we know the genetic basis of life, we can discern two kinds of saltation. One of these was recognized, and dismissed, by Darwin. It is a large jump in "phenotype"—that is, the outward form and function of the organism. These are considered to be virtually impossible, because any large jump, if it is random, is almost certain to be a disaster for the organism. Hitting a malfunctioning watch with a sledge hammer may produce change, but not likely for the better. Such "phenotype" saltations need not be produced by a large change in the underlying genetic code. For instance, replacement of a single amino acid by another can sometimes cause the resulting protein to fold improperly, or to fail to function, with sometimes disastrous consequences. Most cases of the disease cystic fibrosis are produced by a deletion of the three-base codon for the single amino acid phenylalanine in a protein that controls the regulation of salt concentration in cells. The external change produced by this mutation is a large one, and is highly unfavorable to the survival of the person possessing it.

Another example of a small change in the DNA that produces large phenotypic changes is a "frame shift." This occurs when one base pair of the DNA sequence is either accidentally left out or added to a DNA sequence. Since the sequence is read in triplets, such a deletion or insertion will result in a shift to the left or to the right by one letter in the assignment of codons. Hence, downstream of the "error," practically every amino acid assignment will be altered, with massive changes to the protein, and likely catastrophic consequences for the organism.

A second kind of saltation is a "genotypic" saltation, wherein large changes randomly occur within protein-coding regions of the genome. Such a saltation is unlikely to produce favorable change because, if it is truly random, it will almost certainly produce a large phenotypic change, and therefore be unfavorable. In principle, a "genotypic" saltation could produce only a small change in "phenotype," if the genotypic changes somehow cancel each other out, leading to only a small change in phenotype. But such a near-perfect cancellation is unlikely to arise from a random change, just as it is unlikely that a large, random, phenotypic change will be beneficial.

[37]The possibility of impediments to gradualism are acknowledged by Dawkins. For example, despite the supposed ease and rapidity of evolution of the camera eye from a simple photoreceptor cell, the inefficient compound eye of insects has been unable, after millions of years, to evolve into the camera eye. Dawkins suggests that the inverted image of the camera eye represents an inherently discontinuous change from the right-side-up image of the more primitive compound eye. "Finding an intermediate between these two is a tough proposition, to put it mildly," he writes. Thus, the compound eye, though non-optimal, might represent a foothill, separated by an impassable valley from the true optimal eye, which resides on the peak of Mount Improbable itself. The obvious question, then, is "How common are such impasses?" or "How smooth really is the backside of Mount Improbable?"

[38]Dimmock and Primrose, *Modern Virology*, 44.

[39]Ibid., 106, 118.

[40]Ibid., 335–7.

[41]Ibid., 256–75.

[42]Dawkins, *The Blind Watchmaker*, 239.

[43]E. Pennisi, "Is it Time to Uproot the Tree of Life?" *Science* 284 (1999): 1305–7.

[44]J. A. Lake, R. Jain, and M. C. Rivera, "Mix and Match in the Tree of Life," *Science* 283 (1999): 2027–8.

[45]Pennisi, "Is it Time to Uproot the Tree of Life?" 1305–7.

[46]Ibid.

[47]Dawkins, *The Blind Watchmaker*, 105.

[48]C. S. Zuker, "On the Evolution of Eyes: Would You Like It Simple or Compound?" *Science* 265 (1994): 742–3.

[49]A. R. Cashmore, J. A. Jarillo, Y.-J. Wu, and D. Liu, "Cryptochromes: Blue Light Receptors for Plants and Animals," *Science* 284 (1999): 760–5.

[50]Dawkins, *The Blind Watchmaker*, 94.

Communications

Richard Dawkins as Bad Poet

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At the end of his life, physicist Max Born (Nobel laureate, 1954) wrote about an intellectual division between the sciences and the humanities, a division he believed was exacerbated by those in the humanities. He observed:

> My personal experience is that very many scientists and engineers are fairly well educated people who have some knowledge of literature, history, and other humanistic subjects, who love art and music, who even paint or play an instrument; on the other hand the ignorance and even contempt of science displayed by people with a humanistic education is amazing.[1]

The antagonism those in the humanities evidence toward those in science rises and falls with the scholastic tide, as the physical chemist Brian Silver, in his recent *The Ascent of Science*, points out. As examples of writers and poets in the recent, or near recent, past who were highly critical of the scientific enterprise, he refers to Henry Miller, D. H. Lawrence, William Blake, and Thomas De Quincy among others.[2] In quiet counterpoint to these "trashers," Silver peppers his book with literary references that indicate his own familiarity with, and appreciation of, the humanities. But he, too, is keenly aware that today the anti-science tide is at the full, as he relates his own dismay at the aversion so many literati express toward science.

This concern has motivated Richard Dawkins to write *Unweaving the Rainbow*. The title comes from a poem called "Lamia" that John Keats penned in 1820 and in which he laments a "cold philosophy" (i.e., empirical science) that will "unweave a rainbow."[3] Dawkins wishes to respond to Keats by pointing out how science opens the door to a world of wonder that, rather than anesthetizing aesthetic experience, can help one break through "the anaesthetic of familiarity" and see nature in unfamiliar ways.[4] He writes: "Science is, or ought to be, the inspiration for great poetry ... [5] Science is poetic, ought to be poetic, has much to learn from poets and should press good poetic imagery and metaphor into inspirational service."[6]

As one who is keenly aware of the current level of hostility toward science among many trained in the humanities, as one who believes that this hostility is unwarranted, and as one who loves poetry and is acutely aware of the wonder science evokes, I had high hopes for *Unweaving the Rainbow*. However, I believe that Richard Dawkins has failed, not because his basic project is wrongheaded but for a much more interesting reason. He fails because he is a bad poet, and it is science as a vehicle for bad poetry, not science itself, that lies at the heart of the hostility so many aesthetics express toward the discipline.

The problem is metaphor. As Roger Lundin has argued: "Metaphor helps us explicate the symbolic and revelatory grounding we have been given in the world [and] provides us with the assimilative processes by means of which we organize and operate in our world."[7] The role of metaphor in science has gained greater appreciation over the last decades.

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Barry Casper and Richard Noer in their discussion of scientific revolutions conclude:

> The development of a physical theory involves a great deal of guesswork guided by such supposedly nonscientific factors as intuition and aesthetic and philosophical prejudices. In short, it requires a creative insight, an insight glossed over in the usual presentation of the scientific method.[8]

Noting that pre-existing theoretical frameworks help researchers determine the importance of data,[9] Casper and Noer distinguish between "public" science, which presents conclusions in an orderly, logical, and elegant way, and "private" science, which they describe as an "imaginative, intuitive, groping process."[10] Here metaphor plays a key role. Not only do metaphors help researchers structure data into theories, but theories once they are formulated act as metaphors, that is, they become phrases that denote conceptual relationships between objects of study.

Root metaphors are particularly significant. According to Erica McAteer, who uses computer as brain as an example, root metaphors "encode and organize our knowledge about what we experience [and] operate diaphorically. Their function is to suggest a primary way of looking at 'whatever' which will give us a handle for thinking about it." Thus metaphors lie at the very heart of scientific epistemology and help to structure those paradigms through which science moves as it struggles to understand the world. But, as J. P. Moreland has pointed out, science as it grapples with reality assumes a correspondence theory of truth. We arrive at truth when we describe something the way it really is.[13] As Kant would have said, truth is the agreement of the cognition with its object.[14] Dawkins seems to concur with this, as much of his book is an attempt to use science to unmask delusion. Such an intellectual agenda favors concrete metaphors, and the more concrete the better.

Because of their importance, metaphors must be crafted carefully, as a skilled poet would craft them. Dawkins is very aware of this. He writes: "Skill in wielding metaphors and symbols is one of the hallmarks of scientific genius."[15] Then quoting C. S. Lewis's distinction between magisterial poetry where metaphors are used to explain what we already understand, and pupillary poetry where a person uses metaphor as an aid in private reflection, Dawkins focuses on the latter and begins to criticize those scientists who, "drunk on metaphor," that is, "seeing connections which do not illuminate the truth in any way," construct a kind of theology out of science.[16] Among his examples—beyond a few isolated "New Age" quotes with no attribution—are progressive evolution defended by Herbert Spencer, Julian Huxley and Teilhard de Chardin,[17] episodic evolution defended by Stephen Jay Gould and, at least in its punctuationist form, by Niles Eldredge,[18] and evolutionary long jumps or phylum level leaps as described by Stuart Kauffman in *At Home in the Universe* and by Richard Leakey and Roger Lewin in *The Sixth Extinction*.[19]

Dawkins, who in this section evidences a keen eye for faulty metaphor, obviously relishes his role as debunker, one he has played with equal gusto when ridiculing the inanities of astrology[20] or exposing the intuitive errors that underlie much of what we commonly experience as uncanny.[21] Since his purpose is to winnow science from delusion, it seems strange that he would fail so completely when constructing his own metaphors. Yet he does. The metaphors that Dawkins uses are confusing. Thus they do more to obscure the world he wishes to present in a new and exciting light than they do to startle us into a fresh appreciation of it. He does not unweave or reweave the rainbow. Rather, he scrambles it. I will give two examples to illustrate this: (1) his personification of genes (ascribing to them qualities like selfishness or cooperation or experience), and (2) his de-personification of human beings. However, I believe that, when seen against the background of his larger agenda, these metaphors are not so strange. Instead they enable him and other materialists to perform an intellectual sleight-of-hand and pluck the rabbit of consciousness from the top hat of non-consciousness. It is a surprisingly clumsy effort.

Let us look first at the personification of genes. Dawkins' most famous book is *The Selfish Gene*. We read that genes cannot "grow senile," that they are "the immortals,"[22] that from the standpoint of the gene "altruism must be bad and selfishness good" (he tells the reader "this follows inexorably" from

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the definitions he has crafted), and that "the gene is the basic unit of selfishness."[23] The careful reader will notice that Dawkins is using selfishness as a metaphor for stability. He tells us that "atoms tend to fall into stable patterns,"[24] and he reminds us that shorter genetic units (which are collections of stable atomic patterns) are likely to endure over more generations than longer genetic units.[25]

This use of metaphor may strike the reader as strange, and, indeed, it has been the source of much criticism and/or confusion, so much so that Dawkins in subsequent books laments almost pro forma that people have misunderstood him. Of course, quality metaphors are not misunderstood so regularly. We may wonder then why Dawkins persists in using it. Perhaps he is just being provocative, but I think there is another reason. By cultivating the idea of genes as little units of awareness, he wants us to discover that genes are not only selfish. They also cooperate. He writes: "Selection has favored genes that cooperate with others."[26] "Genes are selected, not as 'good' in isolation, but as good at working against the background of the other genes in the gene pool."[27]

These images of genes as selfish personalities that compete and cooperate with one another becomes so ubiquitous in Dawkins' books that in *Unweaving the Rainbow*, he is obliged to remind the reader that "'the selfish gene' is a metaphoric image, potentially a good one but capable of sadly misleading if the metaphor of personification is improperly grasped."[28] A couple of pages later he reminds the reader again that "the personification of the gene is not to be taken literally,"[29] and that the word "experience," so as not to mislead us, "must be taken metaphorically."[30] But what kind of a metaphor is this? How would a book, purporting to be serious science yet describing crystals "metaphorically" as selfish or atoms "metaphorically" as having experiences, be received? What is it that gives credibility to the symbols Dawkins has chosen?

We get a clue to the answer when we compare the metaphors Dawkins uses to describe genes with the metaphors Dawkins uses to describe human beings. If genes "are highly cooperative,"[31] united in "an anarchistic, 'each gene for itself' kind of cooperation,"[32] if "at the genetic level all is selfish, but the selfish ends of genes are served by cooperation at many levels,"[33] then what does he say of human beings? He tells the reader: "You are a gigantic megalopolis of bacteria."[34] By this he does not mean that we are home to many bacteria. He means that because "most of our biochemistry is carried out for us by what were once free bacteria now living in our cells,"[35] "each one of us is a city of cells, and each cell is a town of bacteria."[36] Therefore, we are "gigantic megalopolises of bacteria" because at a fundamental level, we are constructed of bacteria that long ago evolved into cooperating communities. Later he says: "Each individual animal or plant *is* a community ... of billions of cells, and each one of those billions of cells is a community of thousands of bacteria."[37] Break us down to our essential elements and we are revealed as a community of bacteria. In other words, we are depersonalized.

For much of this century, genetics has served to underline the basic similarity of living things. Helena Curtis points out:

> The genetic code is universal. The protein-translating systems of bacterial cells can "read," with almost equal facility, the infectious nucleic acid of polio, of tobacco mosaic virus, or ... the messenger RNA from the cells of the rabbit. The enzyme systems of *Homo sapiens* are little different from those of the red bread mold *Neurospora crassa*. So the slender thread of DNA links us not only to our parents and their forefathers but to simplest of the single cells and to their even more venerable ancestors. There are differences, of course ..., but the essential sameness is what is strikingly clear.[38]

For Dawkins this "essential sameness" becomes a metaphor by which he attempts to dissolve the differences between species.[39] Of course, one could just as well create a metaphor of differences. For example, early in *Unweaving the Rainbow*, Dawkins refers to a biologist who, in an effort to explain his fascination with octopuses, squids, and cuttlefish, tells his listeners: "You see, they are Martians."[40] The metaphor, evoking as it does images of H. G. Wells' *War of the Worlds*, is a brilliant way to capture something of the "otherness" of cephalopods.[41] But sameness is the metaphor Dawkins wishes to stress when he writes of animals and plants as communities of bacteria. Why stress sameness when one could just as credibly stress difference? Why anthropomorphize sub-cellular structures? The reason is that Dawkins is preparing his reader for the final chapters in which he will address the origins of consciousness.

An atheist and materialist, Dawkins must explain to the reader how consciousness arose from insensate matter. In discussing the origins of consciousness, Dawkins uses three root metaphors: (1) the personalized gene, (2) the depersonalized human, and (3) the brain as computer. Encouraging us to think of genes as little experiencing units and to think of humans as vast collections of those little experiencing units, he then throws in some brain-as-computer imagery and—presto—the trick is done.

But how convincing is it if we examine this jugglery in slow motion?

Dawkins follows the American neurobiologist William Calvin and the American philosopher Daniel Dennett in assuming that thoughts do not emanate from some central location in the brain but are generated instead within shifting patterns of activity on the brain's surface. These shifting surface patterns compete Darwinian-like with other shifting surface patterns that simultaneously generate alternative thoughts.[42] In the rivalry between these shifting patterns of activity and competing thoughts, the illusion is born that a single conscious agent sits somewhere in the center of the brain.[43] For most of us, our sense of ourselves as aware individuals is about as real as it gets, but Dawkins argues that the individual and the individual's subjectivity are, in a profound sense, illusions. He claims that the individual organism is not something fundamental to life, but is instead a secondary phenomenon cobbled together by the actions of genes that function in groups as "selfish cooperators." Dawkins uses this insight to argue that the subjective ego each of us feels ourselves to be is itself a "kind of semi-illusion" derived from the clash of agents that are fundamentally independent.[44]

Notice that such a claim is fundamentally incoherent. Illusions deceive, but what, in the absence of a self, is being deceived? Conversely, if there is nothing to be fooled, there is no illusion. These men would justify their use of the word "illusion" by arguing that since the aware and centered self is generated by the actions of systems that are not aware [how do they know such systems are not aware?] and, in some cases, not even obviously integrated with each another, a self does not really exist as a centered entity. Such a conclusion no more follows from these premises than the conclusion that life is an illusion follows from the premise that life is generated by the interactions of systems that are at some basic level nonliving. Therefore, even if we grant the premises, the conclusion is faulty. Perhaps this is why Dawkins prefers the phrase "semi-illusion," but that is no more satisfactory than the phrase "semi-alive" would be in the other context. Worse, the phrase suggests that whatever is being deceived is not really deceived but only semi-deceived. What can that possibly mean? Does Dawkins wish to suggest that we cooperate in our own deception? That we suspend disbelief as when watching a play or film? That the self creates its sense of itself by suspending its own disbelief in its existence? Perhaps Dawkins is using the terms, "illusion" or "semi-illusion," as metaphors for what he really means, but I for one cannot decipher his meaning.[45]

Of course, this semi-illusory, secondary quality interacts with and learns about its world. Dawkins believes that learning is based on a two-tiered intellective[46] structure, which he compares to the hardware and software of a computer. Genes fashion the basic mental hardware that models the environment while memes (i.e., replicators which act as units of cultural transmission and are passed between minds through imitation) create the software.[47] As these two levels interact, "the brain 'reweaves the world,' constructing a kind of 'virtual reality' continuously updated in the head."[48] Indeed, he argues "that all our perceptions are a kind of 'constrained virtual reality' constructed in the brain,"[49] and that our world is a "simulated world ... beautifully in synchrony with the real world."[50] Thus, the semi-illusory self learns about a semi-illusory world, a world Dawkins can describe as being false in the sense of being constructed by the brain around convenient labels by which the brain interprets sensory input.[51]

Notice that what we have here is not an explanation for awareness but a proposed two-tiered, intellective framework that generates shifting patterns of neural activity from which thoughts emerge. These thoughts for their part create two illusions: (1) a simulated world and (2) an illusory self, who interacts with that simulated world. But awareness, the real conundrum, is never addressed. Instead it is assumed, smuggled in through the misleading metaphor of personalized genes, and made credible though the misleading metaphor of a depersonalized self. The hypothesis provides the structure (which incidentally subverts the very correspondence theory of truth with which Dawkins begins)[52] while Dawkins' metaphors provide the mind.

Two bad metaphors do not a bad poet make. Even the great Homer nods. But two bad metaphors, so central to the poetic vision a poet wishes to convey, make a bad poem; a poet who cannot see he has made a bad poem is a bad poet. It is here where Dawkins fails. He is as drunk on metaphor as those he criticizes so effectively, and like them he uses science to theologize.

This is hardly the first time faulty ideas have corrupted scientific thought. An earlier age proposed as a fundamental law of physics that matter cannot be created or destroyed. We now recognize the conceit as false. Indeed, it was not even science at all. It was a philosophical concept tricked out as a scientific one. And it was metaphor since matter was a metaphor for being and being was the question at issue.[53] During that same era, intellectuals adopted the metaphor of life as machine, a trope that continues to mislead

us today.[54] Thus we struggle to interpret the world as much through the symbols we use to help us think about it as through the observations we make and upon which we pretend to base our most important conclusions.

It is here, at the level of metaphor, where so many in the humanities break ranks with scientists. It is not science per se that is the problem, it is the centuries-old arrogance which insists that materialistic science is premiere and that its metaphors ought to define reality for everyone. In the postmodern world, metaphors in the sense of meaningful paradigms or systems (note the plural) have become the only game in town, a reality that Dawkins among others seems unable to grasp. The problem is not his assertion of metaphors, but his confusion of metaphors with truth and, on those grounds, his attempt to exclude all other metaphors but his own. Thus he handles metaphors so clumsily. Clumsy metaphors make bad poetry, and bad poetry grates. ❋

Notes

[1]Max Born, *My Life and My Views* (New York: Charles Scribner's Sons, 1968), 56.

[2]Brian L. Silver, *The Ascent of Science* (New York: Oxford University Press, 1998), see especially "The Tree of Death," pt. IX, chap. 36.

[3]Richard Dawkins, *Unweaving the Rainbow* (Boston, MA: Houghton Mifflin Company, 1998), 39.

[4]Ibid., 7.

[5]Ibid., Preface, x.

[6]Ibid., 233.

[7]Roger Lundin, "Metaphor in the Modern Critical Arena," *Christianity & Literature* 33, no. 1 (Fall 1983): 32.

[8]Barry M. Casper and Richard J. Noer, *Revolutions in Physics* (New York: W. W. Norton & Company, 1972), 6. The role of the aesthetic in scientific theory is significant but perhaps under appreciated. For example, J. P. Moreland in *Christianity and the Nature of Science* (New York: Baker Book House, 1989), despite his conviction that aesthetic considerations play an important role in the development science, he discusses them only briefly (see "The Limits of Science," chap. 3, 128–30).

[9]Casper and Noer, *Revolutions in Physics*, 55, 186, and 248.

[10]Ibid., 229.

[11]Erica McAteer, "Metaphor in Cognition," *Shadow* 4, no. 1 (June 1987): 5.

[12]Ibid., 6.

[13]Moreland, *Christianity and the Nature of Science*, 118–9.

[14]Immanuel Kant, *Critique of Pure Reason*, trans. F. Max Muller (Garden City, NY: Anchor Books, 1966), I. "The Elements of Transcendentalism," *Second Part.* "Transcendental Logic," III. "Of the Division of General Logic into Analytic and Dialectic," 48. He calls this "the nominal definition of truth."

[15]Dawkins, *Unweaving the Rainbow*, 186.

[16]Ibid., 186–7.

[17]Ibid., 192–3.

[18]Ibid., 193–202.

[19]Ibid., 202–9.

[20]Ibid., "Hoodwinked with Faery Fancy," chap. 6.

[21]Ibid., "Unweaving the Uncanny," chap. 7.

[22]Dawkins, *The Selfish Gene* (1976; reprint, New York: Oxford University Press, 1989), 34.

[23]Ibid., 36. On p. 33 he writes: "I preferred to think of the gene as the fundamental unit of natural selection, and therefore the fundamental unit of self-interest. What I have now done is to *define* the gene in such a way that I cannot really help being right!" He very explicitly sets up a circular argument: he assumes what he sets out to demonstrate.

[24]Ibid., 13.

[25]Ibid., 29.

[26]Ibid., 47.

[27]Ibid., 84.

[28]Dawkins, *Unweaving the Rainbow*, chap. 9, 233.

[29]Ibid.,235.

[30]Ibid., 238.

[31]Ibid., 217.

[32]Ibid., 218.

[33]Ibid., 230.

[34]Ibid., 9.

[35]Ibid., 225. He is describing the theory championed by Lynn Margulis that various components of a cell, its mitochondria, chloroplasts (in plant cells), and "moving structures [in cells] like cilia, flagalla, and the 'spindles' which drag the chromosomes apart in cell division" (p. 228), are relics, or as Dawkins says "grinning relics" (p. 227), of ancient bacteria. It is easy to forget while reading these pages that Dawkins is attacking Margulis as an example of "bad poetic science" (p. 224) for he believes that she is basically right but expresses her ideas wrongly. She adopts the combat versus cooperation dichotomy and then stresses cooperation. For Dawkins co-operation rises automatically from genetic conflict and is in fact "a favored manifestation" of it (p. 225).

[36]Ibid., 9.

[37]Ibid., 229.

[38]Helena Curtis, *The Viruses* (Garden City, NY: The Natural History Press, 1965), 207.

[39]This is important to Dawkins since the fewer differences there are, the easier it is to explain how all creatures could have derived from a common ancestor. Daniel Dennett follows the same regime in *Darwin's Dangerous Idea* (New York: Simon & Schuster, 1995), 91–5.

[40]Dawkins, *Unweaving the Rainbow*, 7.

[41]In this case the biologist's metaphor is more powerful than the nineteenth century French romantic Jules Michelet's better known description of squids as "the insatiable nightmares of the sea." It is more powerful because it is more explicitly suggestive, that is, it is more concrete, as required by science's intellectual agenda. An insatiable nightmare might be anything, but a Martian is immediately alien (and may well sport tentacles!).

[42]Dawkins, *Unweaving the Rainbow*, 8.

[43]Ibid., 283–4.

[44]Ibid., 308–9.

[45]Perhaps Dawkins, Dennett, and Calvin are moving toward a Buddhist view of the self. Susan Blackmore who draws heavily from Dawkins touches briefly on Buddhism in *The Meme Machine* (New York: Oxford University Press, 1999)

to help her illustrate what she is trying to say (pp. 194, 230). But that seems equally unsatisfactory since in the Buddhist perception it is not the self but everything including the material world that is illusion, and Dawkins, Dennett, and Calvin are all convinced materialists.

[46]The word intellective is the one Dawkins uses. It is the adjectival form of the word intellect and is intended to underscore the thinking and knowing function of mind over its sensory and willful functions.

Unlike in positivist models, sensory input according to this model does not become knowledge until it is organized and interpreted. One might understand intellective and cognitive as synonyms, but intellective has a broader meaning than cognitive. While cognitive stresses the reflective, contemplative, or meditative functions of mind, intellective emphasizes the reflective and knowing functions equally.

[47]Dawkins, *Unweaving the Rainbow*, 266, 284, and 308.

[48]Ibid., Preface. xii.

[49]Ibid., 57.

[50]Ibid., 281.

[51]Ibid., 57.

[52]A word about how the correspondence theory of truth is subverted is perhaps in order. The correspondence theory of truth defines truth as the agreement of the cognition with its object. It assumes that both the object thought about and the one doing the thinking have an objective reality. But in the model of knowledge proposed by Dawkins neither of these assumptions is fulfilled. The self doing the thinking is not objectively real, it is at best only semi-real, semi- illusory. Nor is that about which the self thinks objectively real. It is instead a simulated world that Dawkins even describes as a false one constructed by the brain as it interprets sensory stimuli.

[53]Antoine Laurent Lavoiser (1743–1794), the French chemist who was guillotined during the Reign of Terror, stated as part of his "law of conservation of mass" that matter could not be created or destroyed. In 1782 Guyton de Morveau published a tentative chemical nomenclature. In 1789 Lavoiser, along with C. L. Berthollet and A. F. Fourcroy, with the publication of *Traite Elementaire de Chimie (Elementary Treatise on Chemistry)*, extended that list to encompass thirty-one elements. Defining elements as substances that resisted experimental analysis, Lavoiser included heat and light among them. In retrospect it seems plain, given the categorization of heat as a substance or light as an element, that chemistry initially focused on the nature of being, rather than on the nature of matter as we understand it today.

[54]In my library is a book published by McGraw-Hill with the unhappy title, *The Machinery of Life*. Written in 1966 by Dean E. Wooldridge, then a research associate at the California Institute of Technology, it is a companion to his *The Machinery of the Brain* which McGraw-Hill published three years earlier and for which Dr. Wooldridge received the AAAS Westinghouse award for science writing. I keep it as a testimony to the tenacity of bad ideas. In the October 1999 issue of *First Things*, William A. Dembski has an excellent article entitled "Are We Spiritual Machines?" in which he discusses how the metaphor of human beings as machines has vitiated not only our self-understanding but our understanding of the tools we have made.

"My big mistake was going into cosmology just for the money."

Teaching Evolution while Respecting Faith in a Creator

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By a 6-4 vote, on August 12, 1999 the Kansas Board of Education deleted most references to evolution from its science teaching standards. Within days, a chapter on geology and paleontology in *Kansas – The Prairie Spirit Lives*, a new history textbook for seventh- and eighth-grade students, was removed by its publishers. The deleted chapter had focused on a prehistoric inland sea and 150 million-year-old fossils found in western Kansas. Director Jim Bean of the Grace Dangberg Foundation, which is publishing the book, explained: "If we talk about [things that old], then it's beyond a creation date that most religions use."[1]

In 1925 Tennessee banned the teaching of evolution, and the famous Scopes trial was held in Dayton, Tennessee. Most biology textbooks published in America since about 1900 clearly described evolution. This was true of the approved Tennessee biology text used by John Scopes. In reaction to the fundamentalist movement of the time, the 1923 edition had already been revised to emphasize that evolution was "only a theory." After the Scopes trial, the 1927 edition deleted all references to human evolution and further downplayed Darwin, simply referring to "his interpretation of the way in which all life changes." Other states also passed anti-evolution laws. In spite of worldwide media coverage critical of William Jennings Bryan's fundamentalism, and despite the eventual overturning of Scope's conviction on technical grounds by higher Tennessee courts, Bryan and his followers succeeded in muting the teaching of evolution in this country for decades.[2]

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Beginning in the late 1960s, federally-funded science curriculum revisions led to a reemphasis of evolution in textbooks. U.S. Supreme Court decisions since then have stricken laws that banned the teaching of evolution, as well as laws that would have required equal classroom time for creationism alongside evolution. But now as statewide science teaching standards are being developed for the first time, we again have attorneys arguing about what the Constitution allows to be taught in science classes. We still have presidential candidates using the everyday sense of "theory" (as a "guess") in reference to evolution, whereas within science "theory" means a well-supported network of related hypotheses. Some atheists are still claiming that evolutionary science disproves the existence of a Creator, while some theists are still touting the gaps in evolutionary explanations as positive evidence for "intelligent design." Is there an approach to origins questions that would seem fair to everyone, including public school students and their parents? Consensus on origins questions is unlikely, but perhaps consensus on *how to discuss* origins questions is more realistic. I suggest five common sense guidelines that may help as we strive toward this goal.

First, we should remember that reality is very complex. Science and religion probe very big mysteries. As my colleague, Dr. Harry Nickla, tells his biology students, "If you ask little questions, you can sometimes get unambiguous answers, but if you ask big questions, you'll have a tougher time." The origins of the universe and life are big questions. Generations before ours have lived and died without complete answers; so will generations after ours.

We are making progress in science and in theology. Hundreds of years from now, teachers will remind their students that those of us here today were not stupid, just ignorant. Yet, those teachers will be pointing their students toward still more questions left to be answered. Good scientists have a keen desire to find natural explanations for things, but they must remember that current explanations are at best incomplete, and maybe even wrong. Good theologians are strongly driven to understand their subject too, yet well aware that theology likewise will continue to progress, and that God will never be fully known this side of heaven. Galileo expressed it well in his letter to the Grand Duchess Christina when he wrote in 1615:

> Who will assert that everything in the universe capable of being perceived is already discovered and known? Let us rather confess quite truly that "those truths which we do know are very few in comparison with those which we do not know."[3]

Second, we should respect theories outside our own areas of expertise. Given the inherent complexity of origins questions, scientists should be extra cautious when passing judgment on creation doctrines, and theologians should be similarly cautious when evaluating the scientific theory of evolution.

Third, when faced with a mystery that has defied scientific explanation, such as the origin of life on earth, we should remember that science itself cannot tell us when all possible natural explanations have been exhausted. When we do not know (or cannot even imagine) a plausible natural explanation, we should readily admit it. It would be presumptuous, however, to assert that no natural explanation *could ever exist* for any particular unexplained phenomenon, even profound mysteries such as the first life form. How can we dismiss all natural mechanisms when we do not even know what we are dismissing? Deductions made through a process of elimination are sound only if one can identify and reject all of the alternatives. Our understanding of biology and the earth's pre-history will likely never be sufficient for us to conclude whether or not life arose via natural processes.

Fourth, because science cannot tell us what to believe in the absence of natural explanations, science cannot rule out the supernatural. Some phenomena may really, in principle, have no natural explanations. Supernatural intervention *could* be essential for life to exist. Those who accept a modern scientific world view are certainly as free as anyone else to *believe* that a Creator, who sometimes acts outside of natural law, exists.

Fifth, we cannot deny that the Creator might work within natural laws, through processes and events for which we do have plausible scientific, natural explanations. Those *explanations* are necessarily mechanistic and impersonal, but not necessarily the reality that they explain. Specific occurrences which we characterize scientifically as random, chance events may be quite predictable, even deliberate, from God's perspective. What we scientifically understand to be processes and events completely determined by autonomous natural laws may be indeterminate from God's perspective, constrained only by God's own regularity and order. Non-interventionist divine action, whether uniform (general providence) or particular (special providence), may exist but be undetectable by science.

In my opinion, a loving, divine Creator could use Darwinian evolution to create. Recognition of pain, waste, and cruel indifference in the world preceded Darwin's theory, of course. In its own pre-scientific, sometimes poetic way, the Bible deals at length and in depth with the problem of evil, both moral and natural. For me personally, Christ's suffering, death, and resurrection give meaning to all of the suffering and death that has occurred throughout the earth's history. Other religious traditions may also have resources for addressing the problem of theodicy within the context of evolution. Loss of religious faith, including Christian faith, is not an inevitable consequence of accepting scientific explanations such as evolution.

I have tremendous respect for the challenging work that elementary, junior high, and senior high school teachers do, and for the work of people who train those teachers. It is up to local school

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administrators, teachers, and parents to preserve an arena within their classrooms where evolution can be taught with respect for science, religion, and students. They might not get much help from the Kansas Board of Education or from textbook publishers, but I am still hopeful. We all want to develop world views based on the very best available knowledge, including scientific, theological, philosophical, and other knowledge. We want that for ourselves, our students, and our children.

Together my family watches public television programs about evolution, *and* we read the opening chapters of Genesis. Taking the Bible seriously without taking all of it literally is something my nine-year-old can do easier than my six-year-old. Our children will develop their own world views, of course. In any case, I do not want mine burdened with the false dilemma of choosing between evolution and creation. Scientific and theological theories can be compared to check for coherence, but only with sophistication and care. As Sir Francis Bacon wrote in 1605:

> Let no man upon a weak conceit of sobriety or an ill-applied moderation think or maintain, that a man can search too far, or be too well studied in the book of God's word, or in the book of God's works, divinity or philosophy; but rather let men endeavor an endless progress or proficience in both; only let men beware that they apply both to charity, and not to swelling; to use, and not to ostentation; and again, that they do not unwisely mingle or confound these learnings together.[4] *

Notes

[1]The decision to delete a chapter from a textbook on Kansas history was reported by the Associated Press in many newspapers, including the *Omaha World-Herald* (August 29, 1999): 16-A.

[2]James W. Fraser reviewed the history of the American creation-evolution controversy in *Between Church and State: Religion and Public Education in a Multicultural America* (New York: St. Martin's Press, 1999).

[3]Stillman Drake, *Discoveries and Opinions of Galileo* (New York: Doubleday Anchor, 1957), 187.

[4]Francis Bacon, *The Advancement of Learning and New Atlantis*, ed. Arthur Johnson (Oxford: Clarendon Press, 1974), 9–10.

SEPTEMBER 2000 TEMPLETON/ASA LECTURES

Sept. 7. 7 p.m. Willard Reading Room, Zimmerman Library. Speaker: Dr. Alvin Plantinga, "An Evolutionary Argument Against Naturalism." Univ. of New Mexico, Albuquerque, NM. Chair: Harold Delaney, (505) 277-5224.

Sept. 13. 7 p.m. Speaker: Dr. Owen Gingerich, "Dare A Scientist Believe in Design." Lewis University, Romeoville, IL. Chair: Sister Noel Dreska, (815) 836-5393.

Sept. 19. 12:30 p.m. Speakers: Drs. Joel Primack and Nancy Ellen Abrams, "God and the Big Bang." Los Medanos College, Pittsburg, CA. Chair: Kate Boisvert, (925) 439-2181 x3277.

Sept. 19. 7 p.m. Nunemaker Hall. Speaker: Dr. Thomas Berry, "Cosmic Liturgy." Loyola University, New Orleans, LA. Chair: James C. Carter, (504) 861-5770.

Sept. 20. 7:30 p.m. Murphy Auditorium. Speaker: Dr. David B. Larson, "Is God Good for Your Health? What Does the Research Say?" Saint Bonaventure University, Olean, NY. Chair: Christopher D. Stanley, (716) 375-2425.

Sept. 21. 7 p.m. Kresge Theater. Speakers: Drs. Mary Gerhart and Allan Russell. Carlow College, Pittsburgh, PA. Chair: John W. Alverson, (412) 578-6078.

Sept. 25. 7 p.m. Nunemaker Hall. Speaker: Dr. Timothy J. Toohig, "Physics Research: The Quest for God." Loyola Univ., New Orleans, LA. Chair: James C. Carter, (504) 861-5770.

Sept. 25. 7:30 p.m. Dr. Holmes Rolston, III. Univ. of Portland, Portland OR. Chair: Thomas E. Hosinski, (503) 943-7454.

Sept. 29. 7:30 p.m. Newman Centre. Speaker: Dr. Ronald Numbers, "The Creationists: History of Scientific Creationism." St. Joseph's College, University of Alberta, Alberta, Canada. Chair: Denis Lamoureux, (780) 439-2648.

Cross-Based Apologetics for a Scientific Millennium[1]

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Weaknesses of Evidentialist Apologetics

One popular approach to Christian apologetics starts with facts and methods of argument to which Christians and unbelievers can agree, and proceeds to construct a case for Christian belief. Such evidentialist apologetics may sometimes be effective in helping to bring people to faith, but there are serious problems with this approach. Theology and science together can help us to develop a better one.

An evidentialist apologetic assumes that there is some common standard for religiously relevant evidence for Christians and non-Christians. We have learned in modern science and mathematics to be wary of common sense because it is inadequate to represent reality. Moreover, all data is theory-laden to a greater or lesser extent. Presuppositions and theories are unavoidable, but problems arise when we are not aware of our presuppositions or think naively that they are the only ones we *could* make.

Christians and non-Christians often share a common understanding of God – the timeless, immutable, impassible One of traditional philosophical theism, "without body, parts, or passions."[2] This God is the God in whom atheists generally do not believe. Many Christians do believe in such a God. So do Jews, Muslims, and the person in the street who professes belief in A Higher Power, The Man Upstairs, or some similar deity.

It may be possible to start from this concept and bring a person to believe the truth of Christianity. But even if this happens, the original concept of "God" is likely to remain unexamined, and to be reconciled only uneasily with distinctive Christian beliefs. These ideas of philosophical theism have been viruses within the body of Christian thought that have weakened the Church and attenuated proclamation of the Gospel. Specifically, they are:[3]

1. Divine immutability and impassibility make the doctrines of the Incarnation and the death of God on the cross *problems* that theologians must solve, instead of solutions to problems. The notion that God is without body or passions contradicts the Christian belief that the One who is true God from true God has a body born of Mary and suffered under Pontius Pilate. (Lest it be thought that ascription of suffering to God is a modern innovation, note the statement of the Fifth Ecumenical Council in A.D. 553: "If anyone does not confess that our Lord Jesus Christ who was crucified in the flesh is true God and the Lord of glory and one of the Holy Trinity: let him be anathema."[4])
2. Related to that failure is the fact that overemphasis on divine unity – that is, the fear of anything suggesting that God has "parts" – results in an effective unitarianism. Again, the Trinity becomes a problem rather than the Christian answer to the question, "Who is God?" What most western Christians think is Trinitarian belief is usually modalism – e.g., the Trinity is like water, ice, and steam.
3. Besides accepting problematic concepts of God, the evidentialist approach also tends to argue for

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design, harmony, and beauty of the world in naive ways. Certainly Christians want to say that the world is designed, harmonious, and beautiful in important senses, and can appeal to things like anthropic principles in support of these claims. But the evolution of life, which anthropic fine-tuning makes possible, is a process in which natural selection—and thus competition, predation, loss, death, and extinction—plays an important role. An apologetic that downplays suffering in the world, explains it with implausible claims about effects of the Fall, or that denies evolution, will be ignored by many thoughtful people.

A Cross-Based Apologetic

For many purposes, and especially when addressing scientifically literate people, it may be better to *begin* with a full, adult, industrial-strength statement of the Christian claim: The most profound understanding of life and the universe is to be found in the suffering and death of Jesus of Nazareth. To use "God" language, we can say: God is revealed most clearly in the cross of Christ.

Is that a crazy idea? Of course! From the standpoint of traditional theism or the corresponding traditional atheism, it is an absurd claim. The question is, however—as Niels Bohr is said to have asked about some new theory—whether it is crazy enough to be true.

Developments in mathematics and physics since the sixteenth century should have taught us not to judge theories by criteria of common sense. Whether the presuppositions of a theory seem plausible *initially* is not the question to ask. We have to work out the consequences of those presuppositions to see how well they help us to understand the world.

The first example that comes to mind is Copernicus's heliocentric theory. In the sixteenth century, the idea seemed ridiculous. Of course everything revolved around the earth—all you had to do was look! If the earth were moving at twenty miles a second, the birds would get left behind. (This was before Galileo's principle of inertia, which also contradicted common sense.) But Copernicus's theory opened up a new way of understanding the world more profoundly and more accurately.

Two centuries ago everyone thought that the true geometry of the world was Euclid's, and Kant even claimed that it was a necessary part of the way our minds grasped experience. Euclid's parallel postulate was considered a "scandal," not because anyone doubted its truth but because it seemed that it should be provable on the basis of the other postulates. Bolyai and Lobachevsky, however, took the radical steps of assuming another postulate about parallels, one which contradicted intuition, and of showing that a geometry just as consistent as Euclid's could be obtained.[5] That showed that there is more than one consistent mathematical system, and became even more important a hundred years later when Einstein based general relativity on Riemann's non-Euclidean differential geometry.

The precursor to that, special relativity, provides a final example. Einstein's postulate that the speed of light is the same for all inertial observers is inconsistent with the common sense ideas of space and time of Newtonian physics. Einstein's answer was that common sense ideas, and especially belief in an absolute time, should be given up. Special relativity is accepted by physicists today not because its postulates have some *a priori* plausibility but because their consequences can explain a wide variety of observational results.

Now when we introduce special relativity to people, we do not try to convince them to believe that the speed of light is invariant on the basis of everyday experience. Instead, we ask them to entertain the *possibility* of that claim, and invite them to consider the world from that standpoint. They can then see that this postulate leads to a better understanding of the world than do intuitive notions of space and time.

Similarly, we should not try to persuade people on grounds of common sense that the fundamental

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level of reality is revealed in Christ crucified. We should be explicit about the ways in which this claim runs counter to common sense, and invite people to consider their lives and knowledge of the world from this standpoint. This does not mean that we ask them to believe something even though it is crazy, much less *because* it is crazy. What we should ask of them is simply a "willing suspension of *dis*belief," supported perhaps by an appeal to the scientific examples we have noted. They can then be brought to see how this idea of God revealed in the cross can address feelings of guilt, lack of meaning, and fear of death. If they have been influenced by scientifically based arguments against religion, they can be helped to see how this concept of God and God's relationship with the world can respond to them, as we will discuss shortly. The hope is that the person will be brought beyond mere intellectual speculation to genuine faith in Christ – bearing in mind that the Holy Spirit, not apologetes, converts people.

We may think of this process in terms of the old analysis of faith into knowledge of what is to be believed, intellectual assent to its truth, and confidence by which one personally appropriates this truth to oneself and trusts in Christ.[6] The approach suggested here is to give people knowledge of what is to be believed full strength, not some watered-down, all-purpose theism: The one who suffered under Pontius Pilate, was crucified, died, and was buried, is true God. Discussion of personal and scientific issues may lead to intellectual assent to the truth of this claim and bring the person to the most important part of faith, trust in Christ crucified, though the point at which that may occur is hardly predictable. But if it happens, the new Christian can start with an understanding of God untroubled by ghosts of philosophical theism. *"The word of the cross is folly to those who are perishing, but to us who are being saved it is the power of God"* (1 Corin. 1:18).

We ought to remember that in the synoptic Gospels, it is at the cross, not the empty tomb, where the pagan world begins to see who Jesus is. The centurion says of the *dead* Jesus, *"Truly this man was the Son of God"* (Mark 15:39).

It is important to realize that this does not amount to saying that Christianity is *irrational*. Rationality refers to the process of reasoning from our initial presuppositions, not to some inherent plausibility of those presuppositions themselves. Philosophy should not impose its presuppositions upon Christian theology, but once Christian theology adopts its distinctive presuppositions it should develop their consequences in rational ways.

Scientific Issues

Previously I have discussed ways in which a theology of the cross provides a context for issues raised by science.[7] Not all of those issues can be considered here, but we may note two which often pose problems for traditional theistic beliefs.

The claim that God is revealed in the cross of Christ is paradoxical, for there God is most deeply *hidden* to those who seek the deity of common sense religion. But this claim sheds light on one problem, the apparent absence of God in the universe. Science enables us to understand what happens in the world without any reference to a deity. That is what we might expect of the God who reveals himself and saves the world in the hiddenness of the cross. The Christian claim is that this God works continually through natural processes which serve not only as divine instruments but also as "masks of God."[8]

We have already pointed out the problems which Darwinian evolution poses for theism with its argument that the development of life has come about through natural selection. This means that suffering, death, and extinction would have to be understood as means by which God creates life, and thus presents an even more severe challenge than the question of how God can *allow* evil. The picture of an immutable God himself immune from suffering who forces billions of organisms through this evolutionary process is difficult to reconcile with ordinary notions of divine benevolence. The Christian claim, however, is that God becomes a participant in this process *on the side of the losers*: In the short term, it is Pilate and Caiaphas who "survive." This does not provide a simple resolution of all the difficulties raised by natural selection, but it provides a

distinctively Christian way of approaching them.[9] It means that with all the evil we encounter in the world, God as "Immanuel" is in it with us.

The Resurrection of the Crucified

It may seem surprising that to this point the resurrection has not been mentioned. There are several reasons for this. First, we avoid getting involved at the start in debates about the historicity of the empty tomb and the Easter appearances. A good case can be made for the basic historical truth of these biblical accounts. The arguments of Pannenberg, e.g., should be studied.[10] But it is simpler to start with an event about which there is little debate. Few serious historians debate the claim that Jesus of Nazareth died by crucifixion under the Roman procurator Pontius Pilate. (Muslims are an exception, but this is due to religious preconceptions, not historical study.)

The plausibility of the resurrection cannot be assessed as an isolated event. It must be considered in connection with the whole life, ministry *and crucifixion* of Jesus. We would have every reason to doubt a claim that someone of whom we knew nothing else was seen by friends after he died and that his tomb was empty. The Christian claim is not the resurrection of "someone" but that of One who believed God to be his Father, proclaimed God's kingdom, showed unconditional love for others, forgave sins, and was obedient to God's will, even to death on a cross.

The most serious problem with the usual presentation of the resurrection is that it comes to be seen as a cancellation of the cross. The cross is thought of as temporary bad news which can be forgotten in the light of Easter. The radical character of the cross, its affront to common sense religion, and also its ability to address issues which common sense religion is unable to deal with, is thereby eliminated. The resurrection does not do away with the scandal of the cross but perpetuates it, for it means that the Crucified is Lord. Paul devoted a whole chapter of 1 Corinthians to the resurrection, but when he first came to Corinth his message was simply *"Jesus Christ, and him crucified"* (1 Corin. 2:2).

Apologetic use of the resurrection can also foster the unhealthy notion that the reality of God is demonstrated only by special miraculous interventions into the natural order. We ought to remember that in the synoptic Gospels, it is at the cross, not the empty tomb, where the pagan world begins to see who Jesus is. The centurion says of the *dead* Jesus, *"Truly this man was the Son of God"* (Mark 15:39).

Some people may be brought to faith by a promise of eternal life, but that is not the approach suggested here. I would urge instead the attitude of C. S. Lewis:

> I believed in God before I believed in Heaven. And even now, even if—let's make an impossible supposition—His voice, unmistakably His, said to me, "They have misled you. I can do nothing of that sort for you. My long struggle with the blind forces is nearly over. I die, children. The story is ending"—would that be a moment for changing sides? Would not you and I take the Viking way: "The Giants and the Trolls win. Let us die on the right side, with Father Odin."[11] ✻

Notes

[1] This is a revised version of a paper presented at the 1999 Annual Meeting of the ASA.

[2] Article I, "Articles of Religion," *The Book of Common Prayer* (New York: The Church Hymnal Corporation, 1979), 867.

[3] For the following issues, see especially Eberhard Jüngel, *God as the Mystery of the World* (Grand Rapids, MI: William B. Eerdmans, 1983).

[4] "The Fifth Ecumenical Council" in *The Nicene and Post-Nicene Fathers*, 2d ser., vol. XIV (Grand Rapids, MI: Eerdmans, 1979), 314.

[5] D. M. Y. Sommerville, *The Elements of Non-Euclidean Geometry* (New York: Dover, 1959), Chap. 1.

[6] Heinrich Schmid, *The Doctrinal Theology of the Evangelical Lutheran Church*, 3d ed. (Minneapolis: Augsburg, 1961), 410–24.

[7] For the following, see George L. Murphy, *The Trademark of God* (Wilton, CT: Morehouse-Barlow, 1986); "Chiasmic Cosmology: An Approach to the Science-Theology Dialogue," *Trinity Seminary Review* 13 (1991): 83; and "The Theology of the Cross and God's Work in the World," *Zygon* 33 (1998): 221.

[8] Martin Luther, "Psalm 147" in *Luther's Works*, vol. 14 (St. Louis: Concordia, 1958), 114.

[9] George L. Murphy, "The Cross Alone is Our Theodicy," *dialog* 36 (1997): 69.

[10] Wolfhart Pannenberg, *Jesus – God and Man*, 2d ed. (Philadelphia: Westminster, 1977), Chapter 3. A more recent discussion, over against the arguments of Gerd Lüdemann, is Wolfhart Pannenberg, "The Resurrection of Jesus: History and Theology," *dialog* 38 (1999): 20.

[11] C. S. Lewis, *Prayer: Letters to Malcolm* (Glasgow: William Collins Sons, 1966), 120.

Considering the Probabilities of Creation and Evolution

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By far the most popular view on origins now held by American evangelicals and fundamentalists is recent creationism. Indeed, in some places it is apparently the majority view, as evidenced by state legislation to mandate the teaching of creation science or to eliminate mention of evolution in the public schools. It holds that, no more than 20,000 years ago, God created everything in the universe in 144 hours. Apart from some general creedal or catechectical phrase like "Creator of heaven and earth" in the Apostles' Creed, it is the only such view I know that has been incorporated into church constitutions and bylaws.

Second in popularity, but lagging well behind, is the day-age interpretation.[1] It usually holds that five of the six days of Genesis 1 are successive ages during which God produced or created the named entities: light, firmament, dry land, plant life, sea life, birds, terrestrial life, and human beings. The fourth day-age is exceptional in that previously existing celestial entities were given a specific task. It is scientifically evident that the universe was created (day 1 of Genesis 1, more than ten billion years ago) before the solar system (day 4, more than four billion years ago); and that the Earth, part of the solar system, formed long before the earliest living things came to be (day 3, necessarily less than four billion years ago, though apparently very ancient). So sun, moon, and stars have somehow to be moved from well before the azoic to at least the Proterozoic to fit this view.

No longer popular is the gap theory, promoted by the Scofield Bible, which holds that an ancient earth was destroyed cataclysmically only to be restored in the six days described in Genesis 1. Since it was formulated in the nineteenth century, its standard version does not take note of the Big Bang. It requires that Gen. 1:2 be read as "And the earth became ..."[2] Never popular were such theories as held that the days of Genesis 1 were literal days of either initiation or completion of developmental ages, which may have overlapped. In what follows, they may be considered versions of day-age theories.

Gordon C. Mills presents a different version of sequential creation, positing the divine introduction of new genetic material from time to time, whereas the usual day-age old earth creationists teach the total miraculous production of new creatures.[3] Mills' view better fits the observed genetic continuity across orders, classes, and even phyla than the commoner sequential creation views.[4]

All these views hold to some form of sequential creation, that is, that God miraculously produced each type of creature, either wholly or partially, at the appropriate time. While day-age theories bypass the pre-biotic physical transformations in these divine interventions, except for the Big Bang, young-earth creationists include the entire universe. Among the described views and their variants, different numbers of creative acts are required: few, if only the progenitors of phyla were thus created; more, if the founders of classes or orders; the greatest number, if species came immediately from God's hand. Most adherents opt for creation at the level of families or genera. Even thoughtful proponents of creation science/flood geology no longer claim that all "true species" were directly created. Although some may hold with genera, the more sophisticated

**ASA Fellow*

among them opt for taxonomic families in the Ark. This suggests that the same level held for the created "kinds."[5] In all of these views, the gap between the created level and the final species, if any, is then bridged by evolution, with microevolution strongly preferred to macroevolution.[6] Indeed, the majority of the proponents of these views hold that "atheistic evolution" is at least redundant, and may be one word, despite its standard spelling. This attitude forces a black-white distinction when there are several shades of gray.

Generally opposed to sequential-creation views is theistic evolution, which is commonly denigrated in evangelical circles. It is held by a small minority of scientifically trained evangelicals, some of whom have been asked not to speak of it in church, with others subjected to ecclesiastical interrogatory. It is, however, commonly espoused by Orthodox, Catholics, and liberal Protestants.[7]

"Intelligent Design" has been suggested as an alternate view which needs to be considered. However, in its most popular version, it is a form of old-earth sequential creationism. Further, the design of all creation by the Supreme Intelligence is a feature of all theistic, and even deistic, views.

It appears to me, though it can be no more than a guess, that the popularity of the sequential-creation views among contemporary Protestant conservatives led to the claim that the probability of evolution given a Creator is lower than one-half, even if the physical data are included.[8] Is this a supportable claim? Various considerations bear on this matter.

Some Superficial Follies

Given the fossil evidence, this range of sequential-creation views provides some superficially possible scenarios. But a closer look at the fossil record, to note but a single sequence among many, shows that there are whales with pelvic girdles and legs, both complete and rudimentary, though these structures are absent or vestigial in the adults of all modern cetaceans. These fossils come at appropriate times to fit a developmental sequence.[9] How can we interpret these and similar fossils?

One possibility is that God, for inscrutable reasons (unless we posit duplicity, a specific intent to mislead human thinkers) before creating the modern species of whales, independently created a series of proto-cetaceans, whale-like creatures which sequentially became extinct.[10] A coupled claim is that descent cannot be proved from the fossils discovered, which is true, though hardly news. Science is not the realm of proof, but of plausible inference. Strict proof has to be left to the mathematicians, where it applies only within sets of axioms.[11] But the basic thought underlying these claims is hardly other than commanding that we not think, unless it be to make the deity devilish.

A seemingly more plausible view on this basis is that the deity was trying various designs until it found a good one. This fits the notion of a limited deity, but with a negative twist, for a vast number of extinct creatures have no modern descendants. Even assuming that they were separately created as means toward refining their design, they represent a great deal of waste, with more fumbling than efficiency.[12] In contrast, a standard traditional view holds that God does nothing in vain. Yet the vast number of throwaway creatures suggests a serious incapacity to get matters right—unless one can demonstrate a need for these "defective" creatures to support the existence of other contemporaneous organisms, already perfected, so that the latter could endure. Alternatively, one might try to show the prototypes necessary to control the number or to promote the development, however limited, of other creatures. Defending such claims appears at least highly problematic. I know of no one who has attempted it.

A related line of evidence makes the situation even worse. Several species of ichthyosaur, efficient air-breathing aquatic creatures with lobed tails, antedated the cetaceans.[13] Although they retained a pelvic girdle and their tails had vertical fins rather than horizontal flukes, they functioned much as porpoises do. Hence, if this premised designer entity did not transfer the functional pattern quite directly, the pseudo-deity would have to have been notably stupid or forgetful—clearly not the Creator of the orthodox creeds. Would any proponent of even the

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most limited deity be comfortable with so pathetic a performance?

If these matters are considered carefully, the traditional view of the deity runs counter to most sequential creation views, but is neutral relative to Mills' view. With the gap theory, it is improbable relative to the recreation, which is similar to recent creationism, but somewhat probable relative to original development. Theistic evolution is also somewhat probable.

Vestiges

Another line of empirical evidence, vestigial organs, has fallen on hard times. It is claimed that about 180 were once listed,[14] including all the endocrine glands, whose function was then unknown. Since much of the century-old list was a demonstration of ignorance, most evangelicals dismiss all references to vestigial organs out of hand. However, whales give evidence very difficult to discount. For example, 20-mm embryos still have external hind limb buds similar to those of embryos of other mammals at corresponding levels of development. Any external indication of hind limbs has disappeared by the time the embryo is about 30 mm long. Adult baleen whales (suborder Mystacoceti[15]) have no teeth. But fetuses have tooth buds in both jaws, just as the toothed whales (Odontoceti) do. Buds continue to develop in the latter, but are resorbed in the former about the time baleen plates begin to form.[16] While other claims of vestigial organs have been dismissed on grounds either that they are precursors to later organs, are essential to embryonic nutrition or have other purposes, it seems impossible to imagine a use for undeveloped teeth, or for resorbed pelvic girdles and hind limbs. One might account for the teeth by the creation of one ancestral cetacean from which both suborders descended. This requires evolution of everything within the order, a higher category than most day-age proponents and all recent creationists will allow. But the limb buds push evolution back to the superorder or subclass level, presenting a graver problem.

Genes

With few discovered exceptions, the "three-letter" genetic codes of DNA and RNA are the same for all creatures, from bacteria to monocots and mammals. Additionally, many developmental controls appear identical across phyla. It has been objected that some similar genes control different functions in different creatures. While true, this may not be germane, for research keeps discovering more genes that exist as families: that is, similar genes in a single species control different processes or produce dissimilar effects. With the expansion of genetic sequencing, more and more gene families are being discovered. So it is probable that the objection is based on the discovery of one member of the gene family in one species and another member of the family in the other species.[17] Consequently it seems probable that more comprehensive knowledge of entire genomes will fully demonstrate the parallels. At least, this appears to me the direction indicated by current discoveries.[18]

This extrapolation is supported by the basic identity of genes across wide taxonomic categories. For example, a gene called *eyeless* in *Drosophila* controls the development of the compound eye. Essentially the same gene is required for the development of eyes in squid and mouse, despite the great differences in their structures. Indeed, the corresponding mammalian gene can replace *eyeless* without changing the dipteran structure.[19] The spread across taxonomic categories is apparently even greater.[20] In addition, a gene product may develop a different function in a more complex chain.[21]

What bearing does this have on the independent creation of many creatures? It suggests that the deity utilizing such restricted means is without imagination and ingenuity, a severely limited entity, not the omniscient and omnipotent Creator of orthodoxy.

Comparing Causes and Effects

A principle which has been widely accepted is the commensurability of cause and effect. Strict application would require that an infinite cause have an infinite effect. But, as commonly understood, it claims only that no effect can be greater than its cause, thereby allowing greater causes to produce lesser effects.[22] Just as a painting does not, indeed, cannot, measure the whole being of a painter, so a finite creation may be produced by an infinite Creator. But the principle further implies that God's creation would most probably be produced instantaneously and totally rather than dribbled out piecemeal over eons—unless the deity is not almighty.[23] One gets a hint that Augustine recognized this in suggesting that the divine act of creation was immediate and all-inclusive, with results that took time to unroll or develop.[24] I find it interesting that most old-earth creationists go along with this developmental approach for the physical universe, from Big Bang to present state. Their rejection of the view applies only to living creatures. They argue that it is impossible for the Creator to have implemented a universe in which life could develop and differentiate without repeated miracu-

lous interventions. Unfortunately, this depends on a view of nature as self-contained, operating on its own internal principles, which is more deistic than theistic.[25] Luther, in contrast, spoke of natural laws as *unser herrn Gotts larven*, latinized as *larvae dei*, the masks of God. That is, we see only the orderly processes of nature although God is the authentic Actor behind all that appears to us. In other words, there is no ultimate differentiation between God as Creator and God as Sustainer and Providence. The difference is one of human viewpoint, of our inexorably temporal outlook.[26]

When these various considerations are pulled together, premising only an omnipotent and omniscient deity, the highest probability applies to an instantaneous and total creation of everything in its finished state. This conflicts with the old-earth creationists' view that, most probably, many miracles of creation were necessary to produce the universe and its inhabitants. It conflicts equally with the views of recent creationists, who also posit a series of creative acts. Though adherents to creation science will object strenuously to this point, once numbers of creative miracles are required, it makes little rational difference whether they occur within 144 hours or over several billion years, or, for that matter, whether genes or whole creatures are involved.

Final Estimates

At first glance, the view best supported by the data cited is that of a deity limited in knowledge, wisdom, and power, feeling its way in an attempt to get things right eventually. This is essentially the god of process theology, though clearly modified, for few, if any, proponents of process theology will accept a deity so restricted. Proponents of this viewpoint ascribe limited foreknowledge to the deity, not limited competence.

A similar interpretation can be applied to recent creationism, where a deity of limited intelligence but vast power might randomly assort various characteristics in order to produce, among the multitude of living things created on the several days, a few viable ones. This seems the most plausible view for them in the light of the vast number of creatures found only as fossils. There are other possibilities. We may join the popular fable about Würzburg professor Johann Beringer, in which they were God's preliminary models for creation.[27] A second view corresponds to Swift's description of the Laputan academy,[28] or furnishing monkeys with typewriters.

There is an alternative view, theistic evolution, that posits an almighty and all-knowing deity who freely chooses process over fiat, though fully capable of producing the universe instantaneously. With this view, the pieces fall together more smoothly. Proto-whales with legs, extinct creatures both with and without descendants, the broad genetic similarities across taxonomic categories—all fit plausibly if creatures are connected by descent according to the divine plan. Granted, there are gaps, both philosophical and empirical, in the scenario. But there is very strong evidence that God used a very slow developmental approach in the inorganic.[29] His purpose in salvation has unrolled slowly, from the protevangelium through the history of Israel and the Church, toward a culmination still hoped for. These considerations support the claim that God acted similarly in providing inhabitants for earth. Properly understood, this view, namely that both the universe and the living things within it slowly developed under God's constant control, excludes both deistic and materialistic tendencies.[30] If one is committed to strict theism, eschewing both deism and panentheism, and looks seriously at all the empirical data, this last view clearly has the highest probability.

One major objection has been raised against this view, namely that the origin of life, the Cambrian explosion, and other discontinuities in the fossil record could not have been produced by divinely controlled development. However, the factors in the inorganic are incredibly improbable also, but are taken as a demonstration of divinely established natural laws.[31] So this special claim about the organic is either a denial of God's competence or a dogmatic declaration that natural laws are inexorable and fully understood.[32] ❋

Addendum

Recently reported Pre-Cambrian fossils found in China indicate that the apparent Cambrian explosion was probably a long-term expansion. It appeared sudden because of problems in the preservation of soft-bodied creatures and the accessibility of such ancient unmetamorphosed strata.

Notes

[1]This view ignores the single day of Genesis 2:4ff, in which birds and quadrupeds were produced after the shaping of Adam and before the building of Eve.

[2]This translation is not recognized in R. Laird Harris, Gleason L. Archer, Jr., and Bruce K. Waltke, *Theological Wordbook of the Old Testament* I (Chicago: Moody Press, 1980), 213f.

[3]Gordon C. Mills, "A Theory of Theistic Evolution as an Alternative to Naturalistic Theory," *Perspectives on Science and Christian Faith* (*PSCF*) 47 (June 1995): 112–22. See also ——, "Possible Role of Protein Modules in a Theory of Theistic Evolution," *PSCF* 50 (June 1998): 136–39.

[4]Indeed, Dean DellaPenna speaks of "interkingdom orthologs" in "Nutritional Genomics: Manipulating Plant Micronutrients to Improve Human Health," *Science* 285 (16 July 1999): 377.

[5]See A. J. Jones, "How Many Animals on the Ark?" *Creation Research Society Quarterly* 10 (September 1973): 102–8; John Woodmorappe, *Noah's Ark: A Feasibility Study* (Santee, CA: Institute for Creation Research, 1996), 5–8.

[6]The development of all historic equids, as specified by flood geology, from a single ancestral pair within the few thousand years since the flood is arguably macroevolution.

[7]This view is not monolithic. While some may argue for a wholly "natural" development, others, like John Paul II, "Message to the Pontifical Academy of Sciences on Evolution" (1996), insist that the human soul was specially created. Others may add life. These are some of the shades of gray.

[8]Alvin Plantinga, "Science: Augustinian or Duhemian?" *Faith and Philosophy* 13 (July 1996): 368–94, esp. pp. 383–90.

[9]Philip D. Gingerich, B. Holly Smith, and Elwyn L. Simons, "Hind Limbs of Eocene *Basilosaurus*: Evidence of Feet in Whales," *Science* 249 (13 July 1990): 154–7; Annalisa Berta, "What Is a Whale?," *Science*, 263 (14 January 1994): 180f; J. G. M. Thewissen, S. T. Hussain and M. Arif, "Fossil Evidence for the Origin of Aquatic Locomotion in Archaeocete Whales," Ibid., 210–12.
This is recognized by Hugh Ross, *The Genesis Question: Scientific Advances and the Accuracy of Genesis* (Colorado Springs: NavPress, 1998), 50.

[10]Ross, *The Genesis Question*, 50–2. Proponents of this and related views need to decide whether the extinctions are "accidental," that is, by natural forces or by deliberate divine action. But this complexity is not germane to the main question addressed in this paper.

[11]Note that it is not possible to have Euclidean geometry without the Euclidean axioms and postulates (called axioms in the modern, complete versions). But one is free to change these to give non-Euclidean geometries, of which there are many.

[12]That it was for the benefit of angels (see Ross, *The Genesis Question*, 55f) is so obviously *ad hoc* that it does not need rebuttal.

[13]Plesiosaurs, pliosaurs, and mosasaurs, also excellent swimmers, did not have a lobed tail.

[14]"A Medical Scientist," *Evolution*, 11th ed. (Toronto: International Christian Crusade, 1951), 19f. The source cited elsewhere is Robert Weiderscheim, *Der Bau das Menschen*, but I was unable to confirm this number in a translation, *The Structure of Man* (1895).

[15]Some taxonomists makes the suborders into orders instead of recognizing Cetaceae as an order. This requires a change in terminology, but no alteration in the point of the argument.

[16]E. J. Slijper, A. J. Pomerans, trans., *Whales*, 2d ed. (Ithaca, NY: Cornell University Press, 1979), 60, 72, and 74. E. J. Slijper and D. Heinemann, "14 Whales (Cetaceans)," in Bernhard Grzimek, *Grzimek's Animal Life Encyclopedia* 11 (New York: Van Nostrand Reinhold Company, 1972), 458; and Gingerich, Smith, and Simons, "Hind Limbs of Eocene *Basilosaurus*," 154.

[17]For example, some members of one gene family promote cell death whereas others tend to prevent it. See Jerry M. Adams and Suzanne Cory, "The Bcl-2 Protein Family: Arbiters of Cell Survival," *Science* 281 (28 August 1998): 1322–6.

[18]Recent work indicates this in plants. See Elizabeth Pennisi, "A Bonanza for Plant Genomics," *Science* 282 (23 October 1998): 654; M. D. Gale and K. M. Devos, "Plant Comparative Genetics after 10 Years," ibid., 656.

[19]Maria Barinaga, "Focussing on the *eyeless* Gene," *Science* 267 (24 March 1995): 1766f; George Halder, et al., "Induction of Ectopic Eyes by Targeted Expression of the *eyeless* Gene in *Drosophila*," ibid., 1788–92; "On the Path of the Primordial Eye," *Science* 275 (28 March 1997): 1885. Walter J. Gehring, "Letters," *Science* 272 (26 April 1996): 468f.

[20]S. Chu, et al., "The Transcriptional Program of Sporulation in Budding Yeast," *Science* 282 (23 October 1998): 704. David W. Meinke, et al., "*Arabidopsis thaliana*: A Model Plant for Genome Analysis," ibid., 681; Paul Berg and Maxine Singer, "Inspired Choices," *Science* 282 (30 October 1998): 874; Stephen A. Chervitz, et al., "Comparison of the Complete Protein Sets of Worm and Yeast: Orthology and Divergence," *Science* 282 (11 December 1998): 2022–8; Gary Ruvkun and Oliver Hobert, "The Taxonomy of Developmental Control in *Caenorhabditis elegans*," ibid., 2033–41.

[21]See Marcia Barinaga, "CRY's Clock Role Differs in Mice, Flies," *Science* 285 (23 July 1999): 506f.

[22]This in no way conflicts with the "butterfly effect," that a small cause, like an infinitesimal air pulse can trigger the events producing a major change in the weather on the other side of the world a month later. The reality is that the cause of the weather is not just the wing beat, which may be viewed as a precipitating cause, but has to include the atmosphere and its stratification, insolation, infrared absorption and reflection, terrestrial rotation, etc., in a complex of factors which have never been completely specified. Note also that someone may choose a different event or state as a precipitating cause.

[23]Here again is the alternative noted earlier: that the deity deliberately created a universe that would mislead. But this is totally out of keeping with Hebrew-Christian principles. It will not be pursued further.

[24]While it is true that Augustine's view was conditioned by a Latin mistranslation of the Greek text of the apocryphal Ecclesiasticus (Sirach) 18:1, it can hardly be divorced from philosophical principles current at the time. Additionally, although not fully argued until *De Genesi ad litteram libri duodecim* (probably begun after 404 and finished before 420), this view is already suggested in *De Genesi ad litteram imperfectus liber* (ca 393).

[25]I have noted this connection in Siemens, "Retrogression and Relapse: About Mills, Moreland, and their Ilk," *PSCF* 47 (December 1995): 284f, esp. p. 285. Traditional deism held that God created the universe and left it to run itself until the day of judgment, when he would intervene. The views evaluated here differ only in positing some divine interventions in an otherwise strictly causal universe.

[26]Traditional Calvinism sharply distinguishes creation and providence. However, Warfield appears to claim that Calvin differentiated them less markedly. See John H. Stek, "What Says the Scripture?" in Howard J. Van Till, et al.,

Portraits of Creation: Biblical and Scientific Perspectives on the World's Formation (Grand Rapids, MI: Eerdmans Publishing Company, 1990), 242–6.

This is not the only matter in which Calvinists mistakenly projected temporality onto the deity. The multi-decade supralapsarian-infralapsarian (sublapsarian) controversy required a before and after in the divine will.

[27]See Martin Gardner, *Fads and Fallacies* (New York: Dover Publications, Inc., 1957), 123f. However, this was not Beringer's view. He ascribed some to the flood, but most to natural causes. See his Chapters III and XIII in Melvin E. Jahn and Daniel J. Woolf, *The Lying Stones of Dr. Johann Bartholomew Adam Beringer: Being His Lithographiae Wirceburgensis* (Berkeley and Los Angeles: University of California Press, 1963), 41f, 101–6.

Note that at the time of his publication (1726), spontaneous generation of insects had been disproved by Redi (1668) and Malpighi (1679), but it was still scientifically correct to claim that "seeds" of marine creatures could be blown into cracks in the earth and grow there. See pp. 38–46, 58–62, 142–53.

[28]Jonathan Swift, *Gulliver's Travels [Third Voyage]*, in *Great Books of the Western World* 36: 109–11.

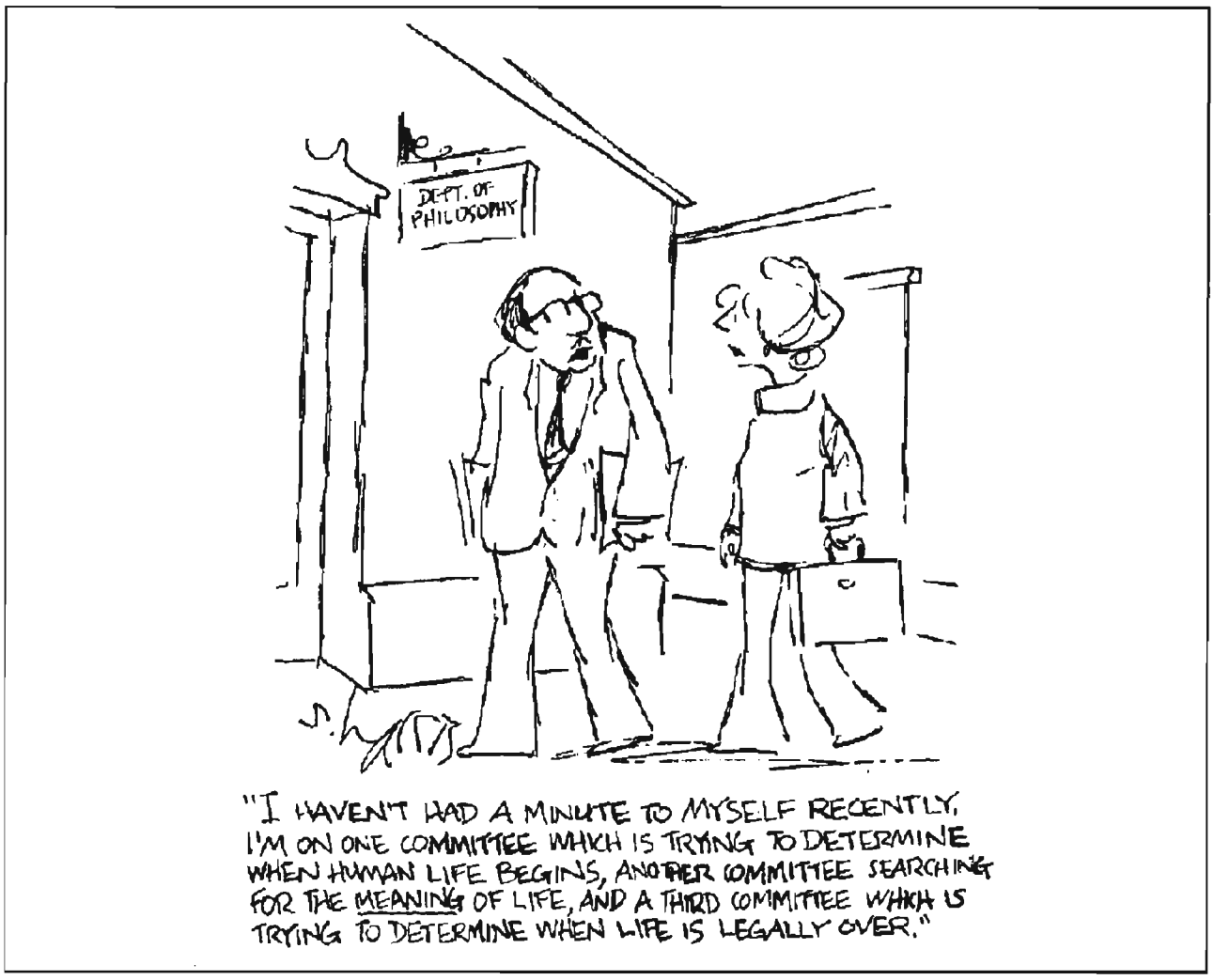
[29]Hugh Ross, "Design and the Anthropic Principle," *The Fingerprint of God*, 2d ed. (Orange, CA: Promise Publishing Co., 1991), 119–38; ——, *The Creator and the Cosmos* (Colorado Springs: NavPress, 1993), 105–36; ——, *The Genesis Question*, 31–3, 36, 43, 151, 180.

Dr. Ross, in his lectures and in *The Genesis Question*, pp. 39–44, 51f, claims that plants and animals were independently created during the third, fifth, and sixth day-ages. So he supports my argument only for the inorganic. However, on p. 46, he argues that the miracle in the inorganic is that the needed factors came out right. So this is a matter of natural law.

[30]This point is lost on most old-earth and recent creationists, for (1) they usually think that materialism and evolution are necessary concomitants, and (2) they do not recognize that their view of nature is essentially deistic.

[31]Ross, *The Creator and the Cosmos*, loc. cit.

[32]The editor, three anonymous reviewers, and George Murphy made criticisms and suggestions which benefitted me greatly. I thank them. They bear no responsibility for any remaining shortcomings.



Book Reviews

Environment

CHRISTIANITY AND ECOLOGY: Seeking the Well-Being of Earth and Humans by Dieter T. Hessel and Rosemary Radford Ruether, eds. Cambridge, MA: Harvard University Press, 2000. 720 pages, index. Hardcover; $38.95; paperback; $26.95. ISBN: 0945454198.

Hessel is Director of the Program on Ecology, Justice and Faith; Ruether is Professor of Theology, Garrett Evangelical Theological Seminary. This is the third volume in the series, *Religions of the World and Ecology*. The conferences, upon which this book is based, were held from 1996 through 1998 at the Harvard University Center for the Study of World Religions.

There are twenty-eight papers, many with responses, by Sallie McFague, Rosemary Radford Ruether, Thomas Berry, Daniel Cowdin, Calvin B. DeWitt, Daniel C. Maguire, Susan Power Bratton, John B. Cobb, Jr., and others. There is an attempt to include all the various points of view that exist among Christians today, such as ecofeminism, Taoism, and the science and religion discussion. There does not seem to be anything that qualifies as *the* Christian position on the environment.

The General Series editor, Lawrence Sullivan, asks in the foreword: "Have issues of personal salvation superseded all others? Have anthropocentric ethics been all consuming? Has the material world of nature been devalued by religion?" He goes on to recognize that Confucianism and Taoism are among the most life-affirming of world religions, but later Heup Young Kim observes that these religions exist in the most "ecologically disastrous areas of the world." In fact no religion has a good record on environmental issues. There is a gulf between rhetoric and performance in all religions.

While noting some exceptions, such as Process ontology, McFague observes that the problem in Christianity is due to the emphasis on the transcendence of God at the expense of his imminence. She notes that an ecological Christology requires the following: justice to the oppressed, including nature; the need to turn to the earth; the recognition that God is with us; the appreciation of the intrinsic worth of all life; and the acknowledgment that human salvation and nature's health are intrinsically connected. Further, ecological Christology defines insatiable greed as sin.

Berry argues that humans' alienation from nature occurred in three rather distinct steps. First was the meeting with Greek humanism as the basis of anthropocentrism, then the Black Death in the fourteenth century for which there was no explanation, and finally the emergence of the industrial non-renewing extractive economy. In asking for a way to recover a sense of the sacred universe, he quotes Saint Thomas: "That the whole universe together participates in the divine goodness more perfectly and manifests it better than any single creature whatsoever."

One of the serious problems with the development of an ecological ethic in Christianity is, of course, Gen. 1:26: "Let them have dominion ..." There have been many attempts to translate "dominion" as stewardship, but Theodore Hiebert says it should be subjugation. He goes on to note that Genesis 2-3, due to the Yahwist author, requires that humans be the servants of the earth.

Cowdin asks: "Does otherkind ... call forth from us a moral response?" He goes on to respond that the moral status of otherkind is tied into the entire theological meaning of creation. Cowdin rejects the claim by Aquinas that since animals are irrational, they have no moral status. He claims that the only right we have relative to animals is the right to serve them. "There is a Christian imperative for merciful and generous ... action toward animals on the model of the higher serving the lower." He challenges us by noting that too much concern for the fine points of moral status is an academic indulgence in these times of looming crisis.

In his paper, "Population, Consumption, Ecology: The Triple Problematic," Maguire asserts that over-consumption by the elite is the primary source of ecological problems. As the wealthiest one-fifth of the world control more than 82% of the wealth, this seems indisputable. The major religions look moribund in comparison to globalized corporations and financial structure. "Religions who would be the moral heirs of the prophets should target these greedy dogs, wolves, snakes, and vipers."

It is impossible to do justice to such a comprehensive volume as this in the space allotted. It is an important contribution and should be consulted by all, especially by those who just wish the whole problem would go away.

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GOD'S WORLD: A Theology of the Environment by Ken Gnanakan. London: Society for Promoting Christian Knowledge, 1999. 229 pages, index. Paperback; $14.95. ISBN: 0281051380.

Gnanakan is a writer, evangelist, theological educator, and director of ACTS Institute in Bangalore, India. This book is the fifth in the International Study Guide series on applied theology published by the Society for Promoting Christian Knowledge. These study guides are designed for students and Bible study groups, as well as for multi-cultural classes and students for whom English is a second language. Study guides in this series are written from a worldwide, ecumenical perspective with an emphasis on the application of the material studied, drawing out its relevance for Christian faith and ministry.

The book begins with a brief summary of the present-day environmental crisis. This is followed by a presentation of three important reasons why Christians should be engaged in environmental action. One of the main reasons for involvement is because all Christians believe in a God who is first and foremost the Creator. Secondly, the Christian doctrine of creation has been attacked for being the root cause of the past and present degradation of the environment. It is therefore up to Christians to set the record straight by correctly interpreting and applying the biblical understanding of the concept of "dominion" as it is presented in the first chapters of Genesis. The third reason for action centers upon the biblical mandate for Christians to be good stewards of God's creation. If we believe that God has entrusted the care of creation to us, we should respond by demonstrating a greater sense of responsibility toward the environment and its resources.

The author's main thesis is that ecological and environmental concerns are very much central to the message of the Bible. In support of this thesis, seven of the fifteen chapters are devoted to the development of a biblical theology of the environment. A number of passages from both the Old and New Testaments are examined in these chapters and the theological implications of these passages are clearly explained. A separate chapter is devoted to a historical survey of the teachings of influential church leaders over the past centuries as they pertain to the biblical doctrines on creation and stewardship of the earth. In another chapter, the author argues that wrong relationships are primarily responsible for the present-day environmental crisis. After critiquing anthropocentric and biocentric relationships, Gnanakan presents a theocentric perspective:

> Pure biocentrism tends to deify nature, while pure anthropocentrism will divinize humans. A relationship by itself with nature will either idolize or romanticize our dealings and not fulfill ultimate purposes that are intended. It is when we relate to a Creator God that all else will take its rightful place (p. 125).

The last chapters in the book deal with issues of equity and justice, concerns from the ecofeminist perspective, ethical guidelines for a proper relationship with the environment, and practical suggestions for the Christian church as a whole. Interspersed throughout the book are a variety of hymns, prayers, and liturgies from a variety of sources which provide direction for the Christian in the worship of the Creator. Also included are a number of documents which contain important environmental action statements. Statements included are the twenty-seven principles from the United Nations Conference on Environment and Development held in Rio de Janeiro in 1992, the ten affirmations drawn up at a World Convocation on Justice, Peace, and the Integrity of Creation from Seoul, Korea, in 1990, the report of the WEF Theological Commission Study on Ethics and Society prepared in 1992, and the Assisi Declarations on Religion and Nature published in 1986. The Assisi Declarations include environmental action statements from Buddhist, Hindu, Muslim, Jewish, and Christian perspectives.

This book could easily be used as a text for a course in environmental studies that is taught from a Christian perspective. Each chapter is introduced with a study aim and most chapters conclude with a series of questions or exercises for further study. The book is suitable for courses taught in Bible schools, Christian colleges, and seminaries located in English-speaking countries around the world. Many previously published books on Christian theology and stewardship of the environment are cited. Unfortunately, the book does not include a listing of these resources in a separate bibliography. Though

the book includes environmental action statements from other religions, the vast majority of the material is drawn from a biblical perspective. Central to the author's approach is the premise that theological beliefs must lead to environmental action. This book challenges all Christians to become more concerned about the environment and to translate that concern into responsible action.

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Ethics

IS THERE A DUTY TO DIE? by James M. Humber and Robert F. Almeder, eds. Totowa, NJ: Humana Press, 2000. 221 pages. Hardcover; $49.50. ISBN: 0896037835.

In 1987, Margaret Battin posed this question to the academic world: "Are there circumstances in which there is a 'duty to die' in order to make a cross-generational distribution of limited health care resources more equitable?" Rephrasing this, would any of us, assuming life is still worth living, consider it a duty to refuse medical treatments meant to extend our life span because of the costs these treatments would impose on others? This is a book of essays, twelve in all, written by respected academicians from eleven different institutions. Seven of the essays are sympathetic to Battin's claim, including one by her, and five are critical of it. The book is the seventeenth annual volume of *Biomedical Ethics Reviews*.

While the editors attempt to provide a balanced discussion across a wide range of opinions on the issues, they have failed to do so. Had this volume been developed one hundred years ago, it would, without doubt, have been filled with reasoned discussion of religious, e.g., Christian, concerns. I find it disconcerting to find no such discussion in any of the papers. Perhaps the arguments would have been much the same, but I wanted to see a contribution from one or more Christian ethicists to help put the others in perspective. I do not label all the contributors as "non-theists," of course; they simply write as if God did not exist. For me, this is not acceptable.

Battin, University of Utah, leads off with arguments related to "global equity." This means one might decide to forgo medical treatment because in doing so others, in Africa for instance, might benefit. She makes a good case for a moral obligation to work for better distribution of health care around the world (16% of the world's population enjoys 89% of all health care expenditures), but does not, she admits, succeed in her primary argument. She thinks, however, that should redistribution ever develop, her argument would succeed.

Jan Narveson, University of Waterloo, argues that the duty to die is morally correct, as long as we primarily see it as part of our commitments to our loved ones and not as a duty entailing enforceable requirements. If it is my duty to die, that is my duty; it is not one which another can place upon me or attempt to enforce. This is one of the better papers in the collection.

Marilyn Bennett, College of St. Catherine, examines several hypothetical cases, concluding that the claim is morally defensible, at least under some circumstances. I found her arguments clear and easy to follow; she establishes the claim with strong arguments.

Robert Ehman, Vanderbilt University, argues for the claim on both teleological and contractarian grounds, finding the first to be more persuasive. He also spends some time examining the meaning of "duty to die," distinguishing it from other types of rights and duties. I found his arguments tough reading.

Michael Almeida, University of Texas at San Antonio, considers two arguments sometimes made that extend the claim to include a right to active euthanasia (the "off grandpa and spend our inheritance" position). He finds these arguments to be flawed. As a grandfather, I am rather glad of that.

Paul Menzel, Pacific Lutheran University, discusses certain implications of the claim. He contends that it is: (1) only a prima facie duty, one that can be outweighed by other moral forces; (2) it is better stated as "a duty to let death come relatively cheaply"; and (3) it is a personal duty, one that does not give others the right to enforce it. With those considerations, Menzel argues that it is a valid claim, a passive "let death come," not a more general duty to die. J. Angelo Corlett, San Diego State University, supports Menzel and extends the argument to cases of criminal justice, showing an inconsistency in Kant's argument against suicide. This paper, while interesting, is off topic.

Rosemary Tong, University of North Carolina, argues that the claim is not safe in our particular society. Her most persuasive points are that the claim should be restated as "the option to die" and that

the claim should be described in the language of caring and choice rather than duty and obligation.

David Drebushenko, University of Southern Indiana, argues against the claim. He observes that the persons who are dying should decide how their assets will be distributed. Family members are free to disagree with such decisions. He agrees that in some circumstances it might be a "good thing to do," but it is not a duty. I suspect that much of his argument would collapse were he and his opponents to come to a common agreement on the meaning of terms.

Susan Anderson, University of Connecticut, examines six cases, starting with the now-famous (infamous?) "attached violinist" case, to ask the question "do we ever have a duty to die?" She concludes that finding such a case is "extremely difficult," but perhaps possible. She concludes that while the claim may not be justified, a weaker claim, "sometimes we do not have the right to something that may be necessary to sustain our life," can be defended.

Judith Kissell, Georgia College and State University, argues that the implications of the claim leave us in a "strange moral situation." She raises many questions, most of which do not appear to be solvable. It was perhaps in reading this paper that I felt the most need for a theistic perspective. Ryan Spellecy, University of Utah, concludes the book by arguing that, while the claim might be valid, implementation problems probably make it infeasible.

In spite of my concerns expressed above, I recommend this book. It is well worth reading, possibly worth keeping. It has encouraged me to look for some of the past sixteen volumes in the series and to look forward expectantly to volume eighteen, *Privacy and Health Care*, due out in 2001.

Reviewed by John W. Burgeson, Stephen Minister, First Presbyterian Church, Durango, CO 81301.

Erratum

The publisher of *Origins: Cosmos, Earth, and Mankind* reviewed in *PSCF* 52 (March 2000): 68 was listed incorrectly. It was published by Arcade Publishing, Inc. Although Dominique Simonnet was one of the authors, the first author listed is Hubert Reeves.

We apologize for any inconvenience this may have caused.

Faith & Science

GOD, HUMANITY, AND THE COSMOS: A Textbook in Science and Religion by Christopher Southgate, ed. Harrisburg, PA: Trinity Press International, 1999. 449 pages, index. Paperback; $35.00. ISBN: 1563382881.

God, Humanity, and the Cosmos is an outstanding textbook for science and religion courses. The underlying premise of the book is that "it is both possible and fruitful to seek to bring the insights and concerns of these two perspectively distinct disciplines together in a mutually constructive interchange" (p. 90). The authors are primarily British (Deane-Drummond, Murray, Negus, Osborn, Poole, Stewart, Watts) with specialization in both science and theology. The chapters quickly progress from a general background of the science-religion dialog to an analysis of the most current issues. Each chapter is written as a self-contained section, ideal as reading assignments, with the book following a historical development of issues in science and religion. Sections of the book are currently available on the web at http://www.counterbalance.org/, featuring links to related topics, graphics, and a glossary.

The book begins with an introductory survey of the models for interaction between science and religion. With the "integration" method defined, the authors develop the topics in the following order; the history of science, modern physics (chap. 3), evolutionary biology (chap. 4), ecology (chap. 6), and the effect of technology (chaps. 10–11). The topic coverage is exceptional, ranging from the more traditional areas, listed above, to psychology and theology (chap. 5). The inclusion of psychology and theology is critical in understanding the relationship between science and religion in the social sciences, particularly with the profound theological issues arising from neuroscience research.

The beauty of *God, Humanity, and the Cosmos* is in providing a comprehensive treatment of a wide range of current science-religion issues. A fundamental understanding and familiarity of science and religion are assumed, but the result is an excellent guide that a teacher can lead students through. Numerous references pepper the text providing potential resources both to classics for the novice and recent releases for the expert, making the book a valuable entry to the most recent work at the science-religion interface (the references are current to 1998). The authors strive to fairly portray all sides of

issues while providing an appreciation for the tensions involved. For example, "science has a particularly ambiguous role in the ecological crisis—having both (a) contributed to the technology responsible for much of the environmental abuse and (b) been the main source of our awareness of the extent of the crisis" (p. 204).

The authors of *God, Humanity, and the Cosmos* are to be commended for providing an excellent resource for teachers and students of science and religion. A scholarly emphasis is admirably achieved in a readable way that maintains an orthodoxy sometimes lacking in publications that desire to be at the forefront of the science and religion dialogue. Either as a textbook or as a reference, *God, Humanity, and the Cosmos* is an excellent book.

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

THE CREATING CONSCIOUSNESS: Science as the Language of God by Arne A. Wyller. Denver, CO: Divina, 1999. 270 pages, index. Paperback; $16.95. ISBN: 0965952169.

The author is an established astrophysicist who also has a doctorate in philosophy. He is a firm believer in evolution if it is understood as the thesis of descent with modification. In this book, he assumes the entire story of chemical and biological evolution as commonly told by the orthodox evolutionists. However, he is one of the growing number of scientists who speak out against neo-Darwinism. His major complaint is that the "Darwinists and neo-Darwinists have never been able to use hard mathematical calculations based on probability theory to uphold the assertion that chance could realistically be the creative agent" (p. 61). He thinks that calculations (e.g., those offered by Robert Shapiro and Fred Hoyle) show that it is quite absurd to believe that an innumerable number of ingenious biological designs on earth can be created merely by chance and natural selection. He also strengthens his case by recounting the history of evolution and notes every now and then that the time available for the evolution of many biological structures is simply not enough.

Although his critique of neo-Darwinism to some extent resembles those offered by the creationists, he is neither a creationist nor a traditional theist. His sympathy lies in the direction of pantheism or panentheism. He draws freely from the ideas of Plotinus, Spinoza, Bergson, Whitehead, de Chardin and so on. He also appeals to the development in contemporary physics, e.g., quantum mechanics, and the speculations of scientists like Roger Penrose to support the thesis that "mentality is a fundamental ingredient in the Universe apart from matter" (p. 230). This is to pave the way for his own solution to the problem of the cause of evolution: the existence of an invisible intelligence field embedded in our earth, the Planetary Mind Field, which continually manipulates the material energy field into evolving life forms (p. 238). The author clearly states that this Mind Field is not identical to the God of traditional religions. It is neither omnipotent nor omniscient, and it is restrained by physical laws. During the process of evolution, this playful intelligence is also evolving and slowly maturing to the point of creating humankind (p. 253). The author believes that the Mind Field can influence human persons by affecting their subconscious. It is guiding the evolution of our culture and religion toward a global community where the society is open and pluralistic and the community is based wholly on the principle of love in a new unstructured religion.

The book is clearly written and should be interesting to many ASA members. Although the author's critique of neo-Darwinism is not very profound and the probabilistic argument against neo-Darwinism is by no means novel, he manages to point to many detailed examples of biological invention within the timetable of evolutionists, the cumulative force of which throws doubt on the sufficiency of chance as the driving force of evolution. For instance, the first cell with its staggering amount of information had to be created in 400 million years (p. 61), more than 200 million species must have been created over a period of only 700 million years (p. 73), around 200 different types of cells had to be created during only a few million years (p. 78), and the evolution of eyes and brains had to be created in relatively short time spans. The book is also instructive and provoking for Christian apologists who attack neo-Darwinism. It reminds us that the downfall of neo-Darwinism does not automatically mean the victory of traditional theism.

The author is not altogether persuasive when presenting his positive proposal, and his Planetary Mind Field theory is vulnerable on many fronts. For the naturalists who reject creationism, the author's theory will be just as far-fetched, if not more. Its explanatory power is also inferior to that of the cosmic designer hypothesis. While the latter can also explain the fine-tuning of the Big Bang and the physical laws, a Planetary Mind Field limited by natural laws can hardly do that. However, something can be further developed along the author's line, and it will

probably result in a position similar to process theology, which may prove to be less vulnerable and quite attractive to those who want to reject a mechanistic world view but are also reluctant to embrace traditional Christian theism. How to speak to these people is an issue well worth pondering, and a challenge the defenders of Christian theism need to face. This book does not articulate the position of panentheism as well as, say, David Ray Griffin does, but it will help us understand why some scientists are attracted to this position.

Reviewed by Kai-man Kwan, Assistant Professor of Religion and Philosophy, Hong Kong Baptist University, 224 Waterloo Road, Kowloon, Hong Kong.

EINSTEIN AND RELIGION: Physics and Theology by Max Jammer. Princeton, NJ: Princeton University Press, 1999. 279 pages, footnotes, index. Paperback; $22.95. ISBN: 0691006997.

"Science without religion is lame, religion without science is blind," declared Albert Einstein in 1940 to the Conference on Science, Philosophy, and Religion. This dictum summarizes Einstein's belief about the relationship between science and religion, and is the subject of Jammer's investigation which proceeds in three steps. First, Jammer explores Einstein's religiosity and private life. Second, he delves into biographies, addresses, and essays to extract Einstein's philosophy of religion. Finally, Jammer concludes with an overview of modern physics' impact on contemporary theology.

Professor of Physics Emeritus at Bar-Ilan University in Israel, Jammer has written books on the foundations of physics, books read in draft by Paul Dirac and Werner Heisenberg. Einstein wrote the preface to Jammer's book, *Concepts in Space*. Thus, Jammer is no small figure in the philosophy of physics. In the present work, he consulted sources from the Einstein Archive, National and University Library in Jerusalem, and the library of the Union Theological Seminary in New York to produce a thorough biographical analysis, unique in its focus on Einstein's religious perspectives.

Because of the influence of Spinoza, the object of Einstein's faith was both impersonal and transcendent. However, Einstein's panentheistic convictions have been misconstrued by atheists and theists alike. Jammer proposes to set the record straight. Einstein once said, "Try and penetrate with our limited means the secrets of nature and you will find that, behind all the discernible concatenations, there remains something subtle, intangible and inexplicable. Veneration for this force beyond anything that we can comprehend is my religion" (p. 40). Jammer's task is somewhat less ambitious than penetrating "the secrets of nature." He merely tries to penetrate Einstein's veneration.

Einstein was a determinist in the strict sense of the word. Despite his disbelief "in human freedom in the philosophical sense" (p. 73), he advocated morality and even religious instruction, provided such instruction avoided unnecessary theological dogma. In fact, Einstein's religion had no room for theology at all. Belief in revelation was unacceptable, as was the notion of a God who would punish evildoers and reward for good. Contrary to the personal God of Christian theism, Einstein's god was unknowable.

Jammer's final chapter is dense in places, but this reflects a high content to word ratio. Less Einstein's thought, more Einstein's impact on thought. Jammer notes that Einstein might actually have rejected the arguments this chapter contains. (Indeed, Einstein did reject the Copenhagen interpretation of quantum physics, on which many theological arguments are based. Jammer conjectures this may be attributed to the Copenhagen denial of determinism.) Jammer presents synopses of the reflections of scientists, philosophers, and theologians on such issues as time, eternity, and process theology; God's foreknowledge and the free will of human beings; indeterminism and local realism; and cosmology and cosmogony.

One of the finest writings on science and religion which I have read, Jammer's book is particularly notable for its scholarship and biographical content. His final chapter is also his weakest. However, his aim is biographical, not philosophical, and in this end he succeeds. *Einstein and Religion* is an excellent book, and most worthy of the effort required to peruse its contents.

Reviewed by John M. Drake, Department of Biological Sciences, University of Notre Dame, Notre Dame, IN 46556.

History of Science

THOMAS HENRY HUXLEY: The Evolution of a Scientist by Sherrie L. Lyons. Amherst, NY: Prometheus Books, 1999. 339 pages, bibliography, index. Hardcover; $54.95. ISBN: 1573927066.

Lyons's biography of T. H. Huxley, self-designated "Darwin's Bulldog," substantially contributes

to the growing body of historical literature portraying the intellectual milieu during the advent of Darwinian evolution. Lyons pursues her subject topically, describing and evaluating Huxley's approach to science and culture: rigorous empiricism. She does not develop the social context for the development of Darwinian evolution; this has been done elsewhere. Lyons's task is to elaborate the role of one man, Huxley, and his acceptance and endorsement of Darwin's hypothesis. She performs this task well.

Lyons presents the development of Huxley's thinking and his disputes over natural selection, persistent types, and gradualism. Dissenting from the popular Naturphilosophen, Huxley nevertheless recognized morphological archetypes and consequent functioning of organisms. Contra Darwin, in Huxley's point of view, form was not derived from function. In her final chapter, Lyons relates the interminable form versus function debate to current scholarship, submitting Brian Goodman's concept of the morphogenetic field and the limits of function.

Most chapters follow Huxley's course toward accepting the mechanisms of Darwinian evolution. Chapter two, perhaps Lyons's most thorough exposition (and for those not interested in the subtleties of theory also the most dry), meticulously distinguishes among competing perspectives of "type" and depicts the surrounding controversy. Chapter three examines Charles Lyell and the concept of saltation. Darwin's reliance on the uniformitarianism in Lyell's *Principles of Geology* is well documented. Huxley, however, was not as quick to apply gradual processes to biological systems. In chapter five, Lyons concludes the issue tracing Huxley through the 1860s as he abandons his previous view and adopts gradualistic evolution.

Chapter four continues to address types, now in the context of geology and paleontology. A significant portion of this chapter recounts Huxley's objection to the argument from design as propounded by leading scientists such as Buckland, Agassiz, Sedgwick, and Owen. This discussion sets a historical context for the current work of intelligent design proponents. Chapter six memorably portrays the hippocampus debate between Richard Owen and Huxley. Owen contended that certain anatomic features were unique to the human species, thus preserving humanity's dignity. Among these features was the hippocampus minor. Huxley, the victor in the debate, also maintained the dignity of humanity, but did not find the grounds for this in either physical or psychical distinction from the animals. The outfall of this debacle reached far. *Punch* published a satirical poem (reprinted in the text) of the event, purportedly authored by a gorilla. *A Sad Case*, an anonymous pamphlet humorously depicting the controversy, was published soon after.

Natural selection is the key hypothesis presented in Darwin's *Origin of Species*. A mechanistic explanation of evolution, it boasts much explanatory power. Huxley, however, challenged Darwin to empirically verify his hypothesis, contending that it was impossible to do so. Chronicling Huxley's dispute with Darwin, chapter seven describes each man's evidence, as well as their philosophical differences pertaining to the necessary qualifications for scientific evidence. Furthermore, Huxley adamantly separated science and theology. The first he considered positive knowledge, the second an abominable morass of unverifiable and inconsistent dogma. In order to describe himself, Huxley coined the term "agnostic," which is not to say that Huxley was indifferent to theology. He certainly was not. Rather, he was indignant of the dogmatic claims of theology and responded hostilely. This agenda is reiterated throughout and brought to life via anecdotes of personal confrontation and contention. Chapter eight "Evolution and Huxley's Worldview," narrates Huxley's antitheological stance. However, Huxley became defensive when labeled a materialist. He "asserted that metaphysics and physics were complementary, not antagonistic, and claimed that 'thought will never be completely fruitful until the one unites with the other.'" Nevertheless, Lyons concludes that if he believed that science provided the only method for establishing knowledge, he should not have been astonished to be called a materialist. I concur.

Lyons's book thoroughly analyzes the one man who simultaneously played roles of scientist, philosopher, and propagandist during the advent of Darwinian evolution. If she is a bit insensitive to the subtleties of current evolutionary theory, she is very aware of the controversy during the second half of the nineteenth century. Lyons simultaneously provides a story of science as it happens and contributes significantly to understanding the history of evolutionary theory. *Thomas Henry Huxley* is recommended as a worthy book in the history of biology.

Reviewed by John M. Drake, Department of Biological Sciences, University of Notre Dame, Notre Dame, IN 46556.

Natural Science

THE LAST WORD: Questions and Answers from the Popular Column on Everyday Science by Mick O'Hare, ed. New York: Oxford University Press, 2000. 229 pages. Paperback; $12.95. ISBN: 0192861999.

This book leaves the big questions ("What is the meaning of life?") to philosophers and addresses the small wonders of daily life. These little questions, or "nagging inconsequentials," include such curiosities as "Why does slicing onions cause tears?" "Why don't birds fall off branches when they sleep?" "Why does lightning fork?" "Why do people close their eyes when they sneeze?" "Why doesn't super glue stick to the inside of the tube?" and "Why is it colder on the top of a mountain if heat rises?"

The Last Word answers these and many other questions. The title of the book is the same as the title of the column which appears on the last page of *New Scientist*, a London-based weekly magazine. The column, where these questions first appeared, is *New Scientist*'s most popular feature. Readers are encouraged to submit questions via e-mail: lastword@newscientist.com.

Throughout the book, black-and-white line illustrations illuminate and amuse. A table of contents categorizes the questions into such areas as "plants and animals," "mysteries and illusions," "gadgets and inventions," and "bubbles, liquids, and ice." An extensive index helps in locating specific topics.

Who might be interested in the book? Budding, young, curious scientific minds. Inquisitive, ever-learning, adult searchers. Trivia collectors of all ages. Professional scientists who specialize in narrow fields. *The Last Word* provides entertainment and information. After all, who doesn't want to know "why men have nipples," "why the sky is blue," "why tea should be made with never-boiled water," and "whether fish fart."

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

XENO: The Promise of Transplanting Animal Organs into Humans by David Cooper and Robert P. Lanza. New York: Oxford University Press, 2000. 274 pages, index. Hardcover; $30.00. ISBN: 0195128338.

Cooper is an immunologist at the Transplantation Biology Research Center at Massachusetts General Hospital and an associate professor of surgery at Harvard Medical School. Lanza is senior director of tissue engineering and transplant medicine at Advanced Cell Technology, Inc.

The authors are indisputably competent to write the book, and it is a good survey of the issues—technical, ethical, economic and social—that arise. They admit, e.g., that the dangers of viral contamination have not been satisfactorily resolved yet; nor has a "humanized" pig, the targeted animal, been created yet. Thus, they are not ready to go to clinical trials. A theme that runs throughout the book is that "demand [for organs] far outstrips supply," and that people "would rather be alive than dead," to quote Sir Peter Medawar. These people are on a crusade to keep patients with failing hearts, lungs, and livers alive, which I suppose is what one would want of a medical doctor. They are interested in having an unlimited supply of these organs, hence the goal of a "humanized" pig that can be slaughtered for its organs without attracting much objection. To arouse sympathy for their goal, they often refer to individual cases of patients they have cared for, most dead, who could have benefitted from a transplant. It is never suggested that we owe God a death.

The chapter on ethical concerns got my attention. The possibility that animals have rights is dismissed with the observations that attitudes toward animals have not been constant over time, and that millions of unwanted pets are "euthanized" annually in the U.S. (Normally they shy away from euphemisms—usually they call it killing.) They offer that the animals will die while anesthetized and that this is certainly more humane than what goes on in uncounted abattoirs in the Western world. (It is worth noting that there are also diverse opinions among Christians on the matter of animal rights. Peter Singer, in his definitive book on the subject, suggests a test: if you would not use a defective human, whose intelligence may be lower than that of the animal, in a procedure, you should not use the animal either.)

They do, however, recognize that a "humanized" pig may present some novel questions. For example, "How many human genes does an animal have to have to gain human rights?" It should be noted that only a small fraction of human DNA produces an observable effect; genetic command and control and phenotypic design integrity is specified somewhere else. They also consider cloning humans (with "reduced mental capacity") for their organs but then they reject the idea because of existing legislation forbidding it and the expectation of more legislation. (Recall that Aquinas stated that because

animals are not rational, they have no moral status. It would seem that the authors are ready to extend this to humans.) In the context of discussing the possible threat to society from a "xenozoonosis," they argue that if there is a great benefit to individuals, they have an obligation to proceed as long as they minimize the risk to society.

This is a well-done book by two who are clearly at the center of the action. If you have been touched by xenotransplantation, or if you want to know the state-of-the-art, you should read it. I am personally chilled by the casual instrumentalism of the authors. I am sure that they are not special cases in this regard. There is no consideration of what society would be like if an unlimited supply of spare parts becomes available. As Huxley predicted, death has become disgraceful, not the sort of thing that is mentioned in polite company. I do think that the modern version of soma is also available.

Reviewed by Braxton M. Alfred, Emeritus professor of biological anthropology, University of British Columbia, Vancouver, BC V6T 2E9.

ATLAS OF EARTH by Alexa Stace. Milwaukee, WI: Gareth Stevens Publishing, 1999. 96 pages. Hardcover; $29.27. ISBN: 0836825055.

For those who still have lingering doubts about whether the earth is really flat, this book should settle the matter. There are numerous photographs from space showing the curvature of the earth. In addition, there are many photographs showing in more detail different geographical areas of the earth.

The book is divided into four parts: the living planet, earth in action, unseen forces, and snapshots of our world. Topics discussed and pictorially illustrated in the four sections include everything having to do with the earth. These include the air, mountains, bodies of water, ice regions, deserts, forests, and fertile land. To assist and educate the reader, there are a glossary, index, and bibliography (including videos and web sites).

This book does not have many pages, but the pages are large, measuring 10 by 14 inches. Given the reasonable price, the large pages, and the extensive color photographs and diagrams, this volume is a good value.

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

Origins

EARLY HUMANS: The Story of Science by Roy A. Gallant. Tarrytown, NY: Benchmark Books, 2000. 80 pages. Hardcover. ISBN 0761409602.

Gallant starts his investigation with the chapter "Where Did We Come From?" and believes that religion provides no answer because of its multitude of conflicting opinions. He writes that the history of humans' search for beginnings has passed from myth to philosophy to science. The empirical approach may have started with Xenophanes in the sixth century BC. His study of fossils led him to the conclusion that much habitable land had once been covered with water. During the Dark Ages, many people believed that fossils were the devil's unsuccessfully attempts to create animals.

Gallant gives the following history. Baron Georges Jean-Leopold-Nicolas-Frederic Cuvier was the first to relate fossil animal structure to their then living relatives, and thereby became the founder of paleontology. While he refused to accept an old idea, i.e., that plants and animals change over time, Charles Darwin's 1859 *Origin of Species* advanced that position, thereby shaking the world of science and religion. Darwin's "survival of the fittest" principle explained why 99 percent of all the species that have ever lived on Earth are now extinct. Nearly 100 years before Darwin, George-Louis Leclerc de Buffon had declared that the Earth had existed for millions of years, contradicting Bishop Ussher's biblical date of creation as 4004 BC. "Today virtually every biologist the world over accepts the idea of evolution as solid fact" although there is disagreement "about the ways evolution works" (p. 13).

Fossil human bones, never shown to the public, are kept in a few museums around the world. Most are about the size of a silver dollar. Eugene Dubois discovered the Java Man, some form of early human, dated at 700,000 years of age. In 1868 in France, railroad workers discovered Cro-Magnon, a skull perhaps 20,000 years old. Fossils of Paleo-Indians, ancestors of Native Americans, are perhaps 33,000 years old. Human fossils found in Israel are perhaps 92,000 years old. In South Africa, human fossils are perhaps 120,000 years old. It is believed that by 50,000 years ago, humans populated virtually every part of earth.

In his summary chapter entitled "How Far Back Do We Go?" Gallant thinks the oldest direct ancestry of humans dates back 33 million years. This creature

is nicknamed "Dawn Ape," its scientific name being Aegyptopithecus (meaning "Egypt ape"). "Sometime between 5 and 7 million years ago, the hominids took one evolutionary path, and the apes took another" (p. 66), says Gallant. People like those living today can be traced back to perhaps 200,000 years. Since that time, "our species has shown little change in anatomy" (p. 68).

Gallant concludes his investigation of the search for early humans: "It is hard to deny that human beings have evolved from earlier hominid groups, which in turn evolved from common ancestors going back more than 30 million years" (p. 72).

This is an interestingly written, though somewhat elementary, story of evolution. It is graced with photographs, drawings, and diagrams. Its conciseness makes it appealing, because, metaphorically speaking, the trees do not obscure the forest. It provides a succinct account of paleontology, the science upon which those who adhere to evolution base many of their conclusions.

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

CRADLE OF LIFE: The Discovery of Earth's Earliest Fossils by J. William Schopf. Princeton, NJ: Princeton University Press, 1999. 355 pages, index. Hardcover; $29.95. ISBN: 0691002304.

Schopf is an internationally renowned paleobiologist/geologist whose work has been recognized by medals from the National Science Board, National Academy of Sciences, International Society for the Study of the Origin of Life, Alexander von Humboldt Senior Research Prize, and two Guggenheim fellowships. He is generally regarded as the "father" of modern paleobiology. He has also achieved notoriety for his outspoken criticisms of both young earth creationism and NASA claims for life on Mars. Readers of this book will better understand why all of the above statements are true.

The author sets out to teach the nonspecialist enough about his subject to understand the basic geology, biology, and chemistry involved in the study of the early Earth, the reasons why such study is tentative and still full of gaps, and how competing claims advanced by scientists and others can be evaluated in scientific terms. This work covers the first 85% of the Earth's history, if current estimates are correct. Most of the narrative is in the first person. As the author points out in the prologue:

> For a science book, this is unusual ... I am not objective about this subject—it's my life, I care about it, and it would be false for me to pretend otherwise. Moreover, it seems to me a lot more fun to read about how science is actually done, and by whom and why, rather than plow through a stuffy accounting of theories and facts. "Fun" is the operative word here. To me, science is enormously good fun! There's hardly anything better than learning something brand new or having a novel idea and then following that notion and finding that it makes sense.

The book is a veritable *tour de force* about scientific methods, their limitations, and the sometimes well-intended but nonscientific extensions often made in this arena. Its explanation of much basic science related to paleobiology is outstanding for its clarity. Many science students at the undergraduate level as well as the interested public will benefit from its clear treatment of a variety of topics.

The first three chapters contain fascinating portraits of some early works in paleobiology and some key problems that must be solved. The middle seven chapters discuss how life begins in the standard evolutionary framework, some cellular innovations and the evidence for their appearance (including stromatolites and cyanobacteria), and the advent of eukaryotic cells. The concluding two chapters discuss foibles, frauds, and the hunt for life on Mars by NASA, politicians, and the press. While clearly committed to certain fundamental positions, Schopf is reasonably careful to distinguish between the facts and interpretation of these facts. He is also quite candid about current gaps in our knowledge of both fossils and fundamental biological, chemical, and geological processes and their interactions.

The writing is clear and reflects the ability of a true expert to take complex topics and make them understandable to a well-educated but novice reader. Many of the explanatory devices used are wonderful examples for science teachers to adapt for their respective audiences. Well-chosen and well-labeled drawings, diagrams, charts, and photographs grace this volume, and a very extensive glossary helps the reader to understand terms clearly. A series of eight color plates in the middle of the book also awaits the delighted reader. Select secondary and primary literature are suggested for each chapter for those who wish to go deeper; several of these sources are also good illustrations of clear scientific exposition.

There is a very clear sense in which this book can be best appreciated as a book about the very nature of science. The ways in which evidence accumulates, the meanings made of the evidence, and the limitations that adhere among differing forms of

evidence are engagingly portrayed in this story. The author's metaphysical commitments and his great love for science both come across strongly within these pages. Anyone suggesting alternatives to Schopf's lifework and its meanings would do well to begin here to gain a clear sense of the task involved and its complexities. This is a magisterial summary of the state of paleobiology as we enter the new millennium.

Reviewed by Dennis Cheek, Director of Information Services & Research, RI Department of Education and Adjunct Associate Professor of Education, University of RI, 255 Westminster St., Providence, RI 02903-3400.

Philosophy & Theology

MUSTARD SEED VERSUS MCWORLD: Reinventing Life and Faith for the Future by Tom Sine. Grand Rapids, MI: Baker Books, 1999. 240 pages; endnotes. Paperback; $14.99. ISBN: 080109088.

Sine is director of Mustard Seed Associates, a futures research consulting firm. He holds a Ph.D. in American History from the University of Washington and has been a faculty member of the University of Washington, Seattle Pacific University, and Fuller Theological Seminary. He has written a previous book entitled *The Mustard Seed Conspiracy.*

Mustard Seed versus Mc World is organized into three main parts: (1) A Crisis of Foresight: Learning to Take the Future Seriously; (2) A Crisis of Vision: Learning to Take the Future of God Seriously; and (3) A Crisis of Creativity: Learning to Take Imagination Seriously. An Introduction sets the stage for Sine's discussion of the three crises he sees in the Church. It describes the growing "McWorld" of globalization and its effects on the Church. Sine draws sharp distinctions between what McWorld is and what the "Mustard Seed" of God's Kingdom is. They hold radically different fundamental values and visions of the future. For example, McWorld defines the ultimate in terms of economic growth and efficiency while the Mustard Seed defines it in terms of spiritual and societal transformation. The former's primary values are individualism, consumerism, and materialism, while the latter's are community, spirituality, and celebration of God's new order.

Icons quickly identify action points and questions for further discussion and thought. This is very helpful and gives the book a Web-page feel. The book is clearly intended as a reference for Christian leaders to stimulate thought and discussion.

Part One mainly focuses on how the Church has become compromised by the globalization, which has occurred over the past decade. In many cases, a globalized lifestyle has been accepted without looking at its inherent assumptions, or "worldview" as Francis Schaeffer has taught. Sine follows secular futurists in the definition of globalization as the acceptance of free market capitalism worldwide. He spends this entire portion of the book showing how truly awful globalization can be spiritually, culturally, and environmentally. I found Part One burdensome, but at times interesting. I had recently finished Tom Freidman's *The Lexus and the Olive Tree: Understanding Globalization,* a more positive view of globalization. It was good to see a Christian critique, but I thought Part One was too long.

This book really heats up in Part Two. At this point, I grabbed my chair because Sine had grabbed my attention. He addresses a topic I think is extremely relevant to all ASA members. He confronts the dualism in the American Church head-on. Do we profess the values of Christ, but live the values of McWorld? Do we tack Jesus on as an afterthought to our lives? I think he makes an excellent case that we have done just that. Christian faith demands radical thinking about *what* we do, as well as *how* we do it.

> No one can argue with the fact that we need to recognize God's hand in all we do, but I am not sure our occupation automatically becomes our calling. Many of those first disciples quit their jobs to advance God's purposes ... Undoubtedly there are Christians who are helping to construct cruise missiles at Boeing, but I am not persuaded that this is a Christian calling, even if they do it with the right attitude.

He then goes on to propose how we can overcome this dualism in practical ways.

Part Three was as exciting to read as Part Two. Sine showed why the Church needs to be imaginative not only to thrive in McWorld, but also to simply survive! He does this by providing numerous examples of what Christians are doing around the world in ways such as food cooperatives, community living, and local agriculture. Each of the examples addresses the homogenizing influence of globalization and substitutes Mustard Seed community. Sine is convinced that people will be hungry for community and this will draw them to the Church. He also believes that this community is the only way Christians can prevent their spiritual lives from being crowded out by the all-consuming stimulation of McWorld. This section is packed with practical advice for Christian leaders to consider for implementation in local churches.

This book is highly recommended to all ASA members, especially young scientists and engineers. It will give that practical advice and provoke the imaginative thought, which young ASAers say they need. I have passed the book to my pastor and lay leaders of my church because it is so relevant to the life we live here in Lake Ridge McWorld, Virginia.

Reviewed by David Condron, Aerospace Engineer, Lake Ridge, VA 22192.

KNOWING WITH THE HEART: Religious Experience and Belief in God by Roy Clouser. Downers Grove, IL: InterVarsity Press, 1999. 204 pages, notes, index. Paperback; $12.99. ISBN: 0830815074.

In the Introduction, Clouser asks: Can we really know God? Yes, he says. He wrote the book with two kinds of audiences in mind: (1) those who doubt their intellectual right to believe in God, and (2) those who do not believe in God but are willing to inquire if there is more to belief than just blind faith. Of course, this book can profit other curious minds as well. Clouser wrote the book as a dialogue in which the nonbeliever (or seeker) is asking questions and voicing objections and the writer responds. Although the book is easy to read, the discussion is not superficial.

Clouser asks: "What is religious experience?" He begins his answer by pointing out that many people think that the findings of science are superior to those of other disciplines. Opposing that view, Clouser argues that the basis for all life and scholarship is faith in some philosophy. He does not limit "faith" to his own Christian faith. Some experiences in life are basic, e.g., "one plus one equals two" or "God exists." These basic experiences cannot be proven; we just know them. Christians know from "experience" that God exists. The statement needs no proof.

Clouser opposes the idea that not going to church makes one nonreligious. Just as believers, so atheists have a basis in life, a religion. He insists that "materialism" is a religion as well. Just like theistic religions, materialism has implications for thinking about the world. If there is no more to life than what we experience now, humans' ultimate destiny is the grave.

Chapter three is a reprint of an essay Clouser wrote for students titled "Self-evident Knowledge." Though this essay may be read separately, it is needed for understanding the remainder of the book. Here Clouser discusses the basis for self-evident truths, truths that do not need supporting statements. For example, "one plus one equals two" is a self-evident statement. Clouser discusses three theories of self-evidency and shows the insufficiency of these theories. His conclusion: "The upshot of all this is that our intuitions of self-evidency attach to more kinds of beliefs and are thus the ground of more of what we ordinarily think we know than has generally been recognized in traditional theories of knowledge" (p. 93).

Chapter four is about belief in God and the axiom of equals. That axiom states that if two things are equal to a third they are equal to each other. Axioms cannot be proved. They are experienced. Clouser points out that many people question the self-evidency of belief in God, but they accept the axioms of math and logic without questioning.

Clouser points out that for Augustine, Calvin, Luther, and Pascal "belief" is a sure knowledge. Added to this list could be Reformed Christians who adhere to the Heidelberg Catechism, which defines "Faith" as "a sure knowledge." No "proof" for the existence of God is necessary, nor possible. It is known "from the heart." The knowledge Christians have about God the Creator who offers forgiveness in Jesus Christ is as sure as the axiom of equals. He argues that to "fairly" reject faith in God, one should join a Christian community for a while and observe. True, one would observe many behaviors which do not agree with a belief in God. Still, only by seeing a Christian community can one claim an empirical trial.

Chapter five deals with objections to belief in God. The first objection mentioned is: "How do we know God speaks to us in the Bible when many denominations exist, each having its own explanation of certain texts?" Clouser writes that 98.5% of Christians agree with the basic tenets of Christianity; the differences are relatively small. Another objection is: "How do Christians know that God speaks to them?" They know, says Clouser, without a doubt. It is "self-evident" that God is speaking to them, especially in the Bible. It does not mean, he says, that every fact described in the Bible happened as described. It does mean, though, that what the Bible says about God is true. He says that objections usually raised against the Genesis account miss the religious focus of it and assume that Genesis attempts to do science. Clouser calls this "the encyclopedic assumption," when the Bible is treated as an information source on virtually every subject. Clouser talks about the days of creation, the story of Adam and Eve, and the evolutionary process and

how it all fits with the story as told in the Bible. Other objections are raised and answered, e.g., about Job. Clouser concludes: "Do not try to fit God in our human way of thinking."

In the last chapter the author cleans up some "loose ends." Clouser, a member of the American Scientific Affiliation who teaches philosophy, is well aware of the different backgrounds and philosophies that guide the teaching at modern universities. He rejects "proofs" for the existence of God, since we "experience" God. He shows that the idea many have of rationality in our world derives from Greek philosophy rather than from a Christian way of thinking. Read the book for yourself. I recommend it to teachers and students. The book would be appropriate for use in discussion groups.

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REASON TO BELIEVE by Maurice Wiles. Harrisburg, PA: Trinity International Press, 1999. 131 pages. Paperback; $14.00. ISBN: 1563383055.

This book is a concise introduction to some Christian doctrines and problems that perplex believers and unbelievers. Wiles, Regius Professor of Divinity at Oxford University, gives his opinion in answering fifteen questions. The following three questions he addresses provide an idea of the scope of this book: (1) Did the virgin birth, the crucifixion, and the resurrection really happen? (2) Is the Christian story true? and (3) If Christianity is true, are all other religions false?

Wiles' answers to these questions, as well as the others he discusses, take on a more liberal than evangelical flavor. A quote will illustrate his disbelief in verbal inerrancy of Scripture: "We cannot be sure that the particular words ascribed to Jesus in the Gospels are words that he himself actually spoke" (p. 53). Of the virgin birth, he writes: "it seems more natural to take it as the common core of a characteristic tale ..." (p. 31). In other words, the virgin birth never really happened.

The contents are easy to read since they are written in nontechnical language. The absence of footnotes abets the progression of thought. An index and bibliography are useful for further pursuit and study. For those convinced the contents of the Bible are to be taken literally, this book may supply more doubts than reasons to believe. To those who want to explore a nonliteral approach to Christian faith, this book is an appropriate introduction.

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

Letters

Taking Genesis as Inspired

Our recent paper, "Genesis Reconsidered,"[1] has been criticized by Seely.[2] He presupposes a model of watertight compartments of knowledge, a strict dichotomy between science and theology. He categorically rejects any legitimacy for our model of harmonization. He arbitrarily assumes that the writings of the biblical authors were absolutely bound to the science of their culture and time. But divine revelation implies the communication of contents at least some of which are unknown. Predictive prophecy concerns historical events hundreds or thousands of years ahead of time, and the retrospective prophecy of a creation account refers to events that occurred eons earlier. It was impossible for prophets to know, from their own cultural background, all of the contents of God's prophecies. They were often confronted with revelations they had to pronounce without fully understanding them (e.g., Dan. 9:20–27; 1 Pet. 1:10–12).

We must not impose on God's Word such artificial domains of knowledge, convenient for us, but foreign to the Bible. Should we prescribe to God which types of content he is or is not permitted to convey in his revelation? It is clear that God's revelation is intimately linked with historical events. In the Bible, it is often impossible to sort out neatly what is theological and what is historical content, and there is no fundamental difference between history and prehistory (or other areas of scientific investigation). A formulation of revelation understandable by the ancients need not imply the use or endorsement of factual errors held in their culture. Thus, it is eminently meaningful to look for a possibility of interpretation that coincides with facts as far as we know them, even though an occasional statement may have been interpreted differently by the ancients, or may have to be interpreted differently in the future. God had the Bible texts written for people of all ages, and he wants them to be trustworthy for all readers.

We are astonished that Seely uses Matt. 19:8 and Mark 10:5 to prove his theory of God's accommodating his revelation to the moral ideas of the time. God certainly did *not* accommodate himself to sin when he showed mercy and help to people fallen into sin! On the contrary, the standards remained unchanged. Jesus told the Pharisees, who were dishonestly testing him, that their interpretation of Deut. 24:1–4 was wrong, that they were distorting God's original intention of Gen. 2:24. God's aim may be higher than some initial learning steps in his educational curriculum of the Torah (Rom. 10:4; Gal. 3:24). This has nothing to do with accommodation. We did not exclude divine accommodation in the sense of divine messages being formulated in words basically understandable by ancients as well as moderns. But the inference that this implied error and myths is neither logical nor based on any facts.

In addition, Seely found fault with some particular details mentioned in our paper. As our interpretation certainly is not perfect, and some of it is quite tentative, we appreciate all comments pointing to problem areas, possibly helping us to revise—not Genesis, but our interpretation.

Seely claims that "in the scientific account, the *entire* earth is *never* covered by water" (his emphasis). This statement cannot be verified, any more than the statement that the earth *was* completely covered by water can be verified. Geologists would consider either model as speculative, unverifiable by today's limited geological understanding of the history of the very early earth.[3] However, from the limited geologic understanding of the early earth and other planets, one can speculate that huge impact events, like the one that might have formed our moon, would not only have evaporated any possible previous ocean, but could have also produced a global magma ocean, with hardly any elevational differences, such that subsequent cooling sufficient to allow water to recondense could possibly result in a global aqueous ocean. In any case, earth's present-day continents and deep sea basins—and earlier ones like them—were formed by plate tectonics in an environment containing liquid water in amounts which may be similar to those on today's earth. Thus, the presumption that the first continent rose out of a global ocean is not as far-fetched as Seely would have us believe. Apparently, Seely assumes that, in order to be compatible with science, Genesis 1 would have to mention the earth's early hot, dry surface. It is, however, obvious that a short account can never be complete—nor does this distract from the truth of the statements it does make. It should have been clear from our paper that v. 2 need not refer to the original state of the earth, whose origin is dealt with in v. 1 already. Verse 9 speaks of "the dry [land]," including the article, which usually indicates that the object is not new. Thus, v. 9 may even hint at the dry land having existed earlier than the ocean now being separated from it. Also, the formulation of v. 9 appears to be incompatible with land floating on water.

Seely's claim that the poetic descriptions of God founding the earth "upon seas" (Ps. 24:2—not 4), or spreading it out "upon the waters" (Ps. 136:6), imply land floating on an ocean is not convincing. The parallel in Ps. 24:2 has "upon the rivers," which are not an ocean. We may translate "above" instead of "upon," so the expressions may just have the sense of "at a higher elevation than," an obvious phenomenological description, without any cosmological implications intended. William Shakespeare certainly did not imagine that his hometown, named Stratford-upon-Avon, was floating on the river Avon, nor do names like Southend-on-Sea indicate that the British think their island is floating on the sea.

The same preposition *'al*, which usually means "on" or "above," is the subject of Seely's next concern, his belief that the ancients believed in a solid dome as a firmament above the earth. His argument that *raquia'*, which he translates as "firmament," rather than "expanse," and all of its cognate words *always* refer to objects which have solidity is not compelling, as we indicated in our endnote 34. We don't quarrel with his idea that the preposition *'al* in Gen. 1:20 *can* mean "in front of," and we agree that the text adds *pnee*, "face," before *raquia'*. But although *pnee*, when used without *'al*, can mean "before," "in front of," the prepositional phrase *'al-pnee* means "over," "on," "in," or "over against," rather than "in front of." But even this translation of *'al-pnee* would not indicate a solid firmament, "in front of" which the birds fly. The sunlit atmosphere looks to us like a blue backdrop, "in front of" which we see birds flying. No matter whether they fly "on," "over," "above," or "in front of" the "expanse" or atmosphere, there is nothing in the expression to suggest a solid dome *under* which they would fly. By substituting "surface" for "face," in order to yield "on the surface of the firmament," Seely is similarly unsuccessful, as this would make the birds fly *above* the solid dome, making nonsense of the statement.

Concerning the flying creatures, we of course did not exclude birds or bats. We just insisted on the inclusion of flying insects, because they were the earliest flyers, in accordance with their placement in Genesis 1. Seely seems to have missed the fact that, in our evolutionary interpretation, the first

occurrence of a group of creatures does not imply that they all appeared at the same time. Thus, we agree that Gen. 1:21 includes birds and bats, but they (in contrast to the insects) came later than the first land animals (v. 24), just as some plants, some fish and the whales appeared later. The text says, "God created ... every winged flyer," but not, "at the same time." We showed that God's creating may refer to both a generic dimension, such as the sentient domain, and individual creatures throughout the history of life, and that he developed all groups of creatures by means of descent with modification to this day.

Finally, we did not deny that many of the ancients may have believed in a flat earth, but we argued that even in the earliest times of humanity, the idea of a spherical earth would not have been very exotic in the thinking of some people, especially if they were familiar with observations on wide plains or the ocean. There is no reason to believe that the earliest Greek philosopher known to have postulated a spherical earth had more scientific information or was more intelligent than some people 1000 or more years earlier. Written records of those times dealing with such topics are certainly sufficiently rare that we cannot claim that we should have found some if they existed. Thus, there is no reason to force biblical texts to support a flat earth mythology. Seely emphasizes that Russell did not consider views of the times when Genesis was written,[4] but this does not invalidate our argument against the globality of a flat-earth myth as the world view of *all* pre-moderns. Tanner refuted the idea that the Bible is talking about the earth as a *planet* like the others, but he did not discuss the question of a belief in its flatness.[5] In any case, whatever the ancients believed, the Bible does not support the erroneous beliefs they might have held.

In conclusion, in contrast to genuine myths, and in contrast to Seely's opinion, Genesis 1 correlates in an amazing way with the scientific picture, as shown in our paper, and Seely was unable to find any substantial flaw not dictated by his prior commitment to a mythological model. His points do not at all represent the "glaring contrasts" he claimed. Space limitations for our paper prevented us from explaining in detail everything we touched on. This may have led to some misunderstandings. We welcome further contributions to the discussion.

[1]A. Held & P. Rüst, "Genesis Reconsidered," *PSCF* 51, no. 4 (December 1999): 231–43.
[2]P. H. Seely, "Genesis Revisited or Revised?" *PSCF* 52, no. 1 (March 2000): 77–8.
[3]We thank C. A. Hill and S. O. Moshier for their helpful personal communications.
[4]J. B. Russell, *Inventing the Flat Earth: Columbus and Modern Historians* (Westport, CT: Praeger, 1997).
[5]W. F. Tanner, "'Planet Earth'? or 'Land'?" *PSCF* 49, no. 2 (June 1997): 111–5.

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Early Carnivorous Activity?

In his article on "Disease and Dying" (*PSCF* 51 [December 1999]: 226), Clarence Menninga quotes Henry Morris as having written that there was "nothing bad in that created world, no hunger, no struggle for existence, no suffering, and certainly no death of animal or human life anywhere in God's perfect creation ... no carnivorous activity at that time." In his article, Menninga shows, I think quite convincingly, that the existence of death and disease in the pre-fall world is not inconsistent with biblical teaching, that the "goodness" of creation need not be taken to exclude death and disease. But Menninga did not directly comment upon Morris's reference to carnivorous activity.

That carnivorous activity existed before the fall certainly cannot be doubted. The problem is that this seems to directly contradict the Genesis account. To humankind God said, "I give you every seed-bearing plant on the face of the whole earth and every tree that has fruit with seed in it. They will be yours for food. And to all the beasts of the earth and all the birds of the air and all the creatures that move on the ground—everything that has the breath of life in it—I give every green plant for food" (Gen. 1:29–30). The word "only" does not occur in the passage, but it hardly seems possible to understand this prescribed diet as anything but purely vegetarian, especially in the light of the post-Flood instructions given to Noah: "Everything that lives and moves will be food for you. Just as I gave you the green plants, I now give you everything" (Gen. 9:3). It may simply be a lack of intelligence or education on my part (I am neither a scientist nor a theologian), but I cannot imagine any contortion of evangelical hermeneutics that will enable me to square the scientific evidence with the biblical account.

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Evolutionary Theory Misunderstood

I am proud to be a member of ASA, without doubt America's foremost organization to foster study of the relationship between science and Christianity. In the hope of a continued strengthening of this organization, I respectfully offer criticism of two papers. Specifically, both J. Bergman and M. C. Morris published papers critical of evolutionary biology in a recent issue (*PSCF* 52 [March 2000]: 18–30, 55–7). I believe that the theses of both are based on misunderstandings of biology.

Bergman claims that the vertebrate eye, with its "inverted" retina, is not a poor design relative to a "verted" retina, contrary to the views of prominent figures like R. Dawkins, G. C. Williams and J. R. Diamond. Bergman defends this claim in two portions: (1) "no evidence exists to support the claim that the most advanced verted eye is superior to the inverted eye," and (2) "If the human retina were verted, we have no evidence that vision would be better. Most likely it would be worse." To support the first statement, Bergman shows how even the most advanced extant cephalopod eye is inferior in function to the vertebrate eye. This is irrelevant to the point of the biologists cited in the beginning of the paper, however. Their point is not that a verted eye better than our own exists somewhere on earth, but that the inverted structure we have is not the optimal design from a theoretical standpoint. The verted design can be functionally superior to the inverted *per se* regardless of whether any verted eyes in existence are functionally better than any inverted eyes. It is far from surprising, then, that biologists have not sought evidence for better vision in the octopus than the human.

The second portion of Bergman's claim is defended by a physiological account of how vertebrate eye functionality would be altered if the retina were manipulated to the verted design. He rightly claims that problems as diverse as sensory overload and ultraviolet damage would probably result from such a manipulation. This too is irrelevant to the point at hand, however, since no one has postulated that eye functionality would improve with such a manipulation. Rather, the point is that if vertebrates had evolved an eye in the verted design, our vision would have developed more efficiently because of, among other things, the forward orientation of the sensory cells and the lack of a break in the retina to accommodate the optic nerve. An understanding of natural selection makes plain that, had evolution proceeded differently, and humans were walking around today with verted eyes, we would not be experiencing sensory overload and painfully shading our eyes from UV damage. No evolutionary biologist would propose the ridiculous notion that a physician could mimic an alternative course of evolution by surgically reverting the retina which has evolved in an inverted situation. Both parts of Bergman's thesis, therefore, are based on misunderstandings of the evolutionary biologist's claim about the eye, and of the way evolution works.

Other evidence of a misunderstanding of evolution can be found in the paper. "Darwinists," Bergman writes, claim that "the natural world is in fact not designed." In fact, Darwinists do claim that the natural world was designed, and is still being designed. Evolutionary biology indicates natural selection as the mechanism by which design was and is being effected, though of course biology has nothing to say about either the "purpose" or "agent" of this design in a metaphysical or theological sense. The idea of optimization is central to evolutionary biology, and optimization is the hallmark of design; and we do see much evidence of such optimization, such design, in the vertebrate eye, despite the inversion of its retina.

Another profound misrepresentation of evolution lies in Bergman's claim that no "transitional forms" or other evidence supports the evolution "from the primitive verted type common to invertebrates into the inverted eye of vertebrates." No biologist claims that extant invertebrates such as the octopus evolved into extant vertebrates such as humans; to suggest this is to commit the most basic error in thinking about evolution. All extant organisms are the tips of long branches, and no morphological structure on one tip is inherited from that of another. In fact, evolutionary biology concludes that modern cephalopods and vertebrates share their most recent common ancestor very early in animal evolutionary history, at the split of the deuterostomes and protostomes hundreds of millions of years ago. The "primitive" situation is clearly not the verted retinal structure, but no retina at all! The pinhole eye of cephalopods and the lens eye of vertebrates have evolved independently from each other, and from the compound eye of insects. To suggest that we look for transitional forms between these types of eyes is illogical. There is absolutely no disagreement in evolutionary biology about these particulars, and any respected introductory biology text presents this same situation.[1]

Morris's paper on altruism in nature commits similar errors in that his thesis is based on a misrepresentation of basic biological principles. Morris claims that "Darwinian mechanisms" cannot explain instances of altruism in nature, so we should see the instances of such altruism as "proof of God's

creation." After describing a few means whereby evolutionary theory predicts complex interaction among individuals that can be loosely termed "altruism" (although without the psychological or intentional connotation of that term), Morris goes on to suggest that instances of cooperation in fish, ants, plants, and even cells are inexplicable by these mechanisms. On the contrary, clear explanations in biology are widely known to apply to all of these circumstances. These four explanations show how the evolution of such complex behavior can follow directly from the basic principles of evolutionary theory. This having been said, these evolutionary explanations are, of course, silent on the issue of whether God created the world or, if so, why he created it the way he did.

1. **Cleaner fish—predator interactions:** The benefits to cleaner fish and predators are simultaneous, and therefore no net fitness cost is incurred by either individual. The fact that predators do not eat the cleaner fish simply illustrates that the benefits to the predator of having parasites removed from their mouths is greater than the benefits that would be gained—either nutritionally or by decreasing the cleaners' aid to competitors—by eating the fish.

2. **Ant—caterpillar interactions:** Concerning the interactions between ants and caterpillars, Morris claims that caring for caterpillars or their pupae after their period of usefulness has passed "would not be advantageous from a Darwinian point of view." This is clearly false. Imagine the difference between two populations of ants: one that ate or ignored post-productive caterpillars, and another that continued to care for them. More caterpillars would reach reproductive maturity and lay eggs in the vicinity of the more helpful ants. Thus, the more helpful ants over the generations would be more successful than the less helpful ants because of the more substantial population size of the caterpillars that produce their food. Seeing the populations in an evolutionary (Darwinian) perspective again renders the situation easily explicable.

3. **Neighbor interactions in plants:** The exploitation by neighbors of protective substances emitted by a plant is explained in very straightforward terms in evolutionary biology. The production of a protective substance will be naturally selected in plants even if neighbors can benefit from it, as long as the benefit accruing to one genetic individual of producing the toxin is greater than the cost. This cost includes the energetic expenditure of producing the toxin, as well as any competitive cost of helping unrelated neighbors. The relevant benefit here is that instead of being destroyed, the plant is only partially eaten, or not eaten at all if the herbivore knows (e.g., by experience) to avoid the plant. So it is easy to see why such toxin production continues from an evolutionary perspective. In fact, in these harsh habitats where such toxins are common, neighboring plants may gain more mutual benefits by facilitation than they would harm by competition. This added layer of complexity is still squarely within the Darwinian framework. (It is similar to the cleaner fish-predator interaction.)

In many cases, even the moderate level of explanation just offered is unnecessary to account for plants benefitting their neighbors. First, many plants are significantly clonal, such that nearby stems may appear to be separate individuals but are actually genetically identical to each other. Even complete sacrifice of a portion of a genetic individual (in botanical terms, one or more ramets) would be predicted by evolutionary theory if benefits accrued to the genetic individual's survival and reproduction as a whole. Second, plants whose seeds germinate close to them (i.e., plants with limited dispersal) will tend to be clustered, such that neighbors are much more likely to be genetically related than would be expected by chance. In these instances, benefitting one's neighbors is benefitting one's genotype as it is instantiated in closely related individuals (kin selection).

4. **Endosymbiosis:** The last specific instance Morris provides of supposedly evolutionarily inexplicable altruism in nature is the "cooperation" between cells that is hypothesized to have taken place in the early evolution of eucaryotes. This interaction involves the symbiosis of a bacterium and a larger cell, where one individual resides within the other, each reaps simultaneous benefits from the interaction, and there is no net fitness cost of doing so. Such an interaction is one of a class called *mutualism*, which is an extremely common and evolutionarily straightforward situation. On the other hand, in instances where there is a fitness cost to an organism of harboring another, the symbiotic interaction is labeled *parasitism*. Morris assumes that evolutionary biology predicts that all symbioses are parasitic, which is simply not true.

Therefore, all of the examples Morris adduces in support of his thesis that Darwinian mechanisms cannot explain altruism in nature are misguided. Moreover, the errors committed are on points so fundamental to biology as to exhibit a serious lack of consideration of the science. In actuality, more complex and difficult situations than the ones Morris presented do exist in nature, where biologists are still attempting to determine what evolutionary

mechanism resulted in certain types of complex social behaviors. Even if some of these had been cited instead of the relatively uncomplicated examples above, biologists know better than to bank heavily on our lack of understanding of natural phenomena. A more successful, more humble, and theologically more respectable attitude is to admit our present ignorance, and search for an answer with an open mind.

Incidentally, the above instances have nothing to do with the notion that "all human morality can be reduced to the random action of selfish genes," which Morris falsely claims to be "the inevitable logical conclusion" of Darwinian mechanisms. This issue is another one altogether, but as Morris does not expound upon it, neither will I.

These two papers offer arguments that exhibit misunderstanding of elementary principles of modern biology. The arguments are actually based on these misunderstandings and cannot be sustained without them. As suggested in my above argumentation, the errors committed in these papers could have been corrected with an attention to any of the many thorough introductions to general biology or evolutionary biology which are in wide use today (e.g., those by Campbell, Keeton and Gould, Purves et al., Futuyma). Certainly a reviewer with a professional background in the disciplinary area germane to the papers would be expected to have caught such gross misrepresentations. I take this opportunity to offer criticism so that an awareness of the problems involved may develop in prospective authors, and so that the reviewing process for the journal may continue its growth in scientific attentiveness.

[1]E.g., William T. Keeton and James L. Gould, *Biological Science*, 5th ed. (New York: W. W. Norton, 1993), 673, 1038.

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On Zoeller-Greer

I want to comment on the recent article by Peter Zoeller-Greer, "Genesis, Quantum Physics and Reality" (*PSCF* 52, no. 1 [March 2000]: 8–17). This is certainly the finest article I have read in the journal in over forty years.

It is extremely interesting, not obvious (to me and most of your readers), and very important. I hope it will be followed by a book. Thank you for printing it.

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On Lessons from the Kansas Decision—Revisited

This is a response to the News and Views article, "Lessons from the Kansas Decision" by Robert Newman (*PSCF* 52, no. 2 [June 2000]: 83–4). Despite the claim of Newman's article, the situation in Kansas is not the result of a conflict between naturalistic and theistic world views. Rather it is the consequence of the effort of a few to conform public education to their particular narrow religious and political views.

The 27-member committee appointed by the Kansas Board of Education to write the standards document was not some scientific elite of philosophical naturalists. Of the 27 members, all but one were current or past K–12 teachers, and many have made important contributions to advancing science education in Kansas. Most had well over ten years of teaching service in Kansas public schools, and the committee as a whole had over 400 years of combined in-class K–12 teaching experience! This dedicated group devoted over thirteen months to the writing of the standards. Their document went through several drafts and several rounds of public comment. Despite this work, the final document (fifth working draft) was rejected by the board and not even brought up for a vote. The portrayal of the work of these teachers, many of whom are committed Christians, as some effort by an atheistic elite to impose its will on Kansas children is an insult to these individuals.

Nowhere in the committee's document was evolution presented as a fact or as an ideological position. There were also several explicit statements with regard to teaching with tolerance and respect. The following is from the introduction: "Science studies natural phenomena by formulating explanations that can be tested against the natural world. Some scientific concepts and theories (e.g., blood transfusion, human sexuality, nervous system role in consciousness, cosmological and biological evolution, etc.) may conflict with a student's religious or cultural beliefs. The goal is to enhance understanding, and a science teacher has a responsibility

to enhance student's understanding of scientific concepts and theories. Compelling student belief is inconsistent with the goal of education. Nothing in science or in any other field of knowledge shall be taught dogmatically."

Contrary to the implication of Newman's article, evolution was defined several times within the document. The twelfth-grade Benchmark: "Students will understand major concepts of biological evolution" included the following definitions:

> Macroevolution has been defined as evolution above the species level; the evolution of higher taxa and the product of evolutionary novelties such as new structures (Mayr, 1991). Macroevolution continues the genetic mechanisms of microevolution and adds new considerations of extinction, rate and manner of evolution, competition between evolving units, and other topics relevant to understanding larger-scale evolution.

Further,

> Microevolution has been defined as the process (mostly genetic) that operates at the population level: Natural selection, genetic drift, gene flow, and others. These processes may produce speciation, the splitting off of new reproductively isolated species.

Nowhere in the standards was evolution described as being an "unplanned, unsupervised, purposeless process." To imply otherwise is irresponsible.

The changes and deletions made in the document by the Kansas Board of Education majority went far beyond just removing references to macroevolution. For example, the entire twelfth grade benchmark on evolution mentioned above was removed, including its discussion of microevolution. The standards approved by the Board not only eliminated the theory of evolution as a model for understanding the history and diversity of life, it also eliminated cosmology (Big Bang), references to an ancient Earth, as well as discussion of resource depletion and global environmental issues such as global warming. These changes were made with the assistance and direct input of the Creation Science Association of Mid-America (CSAMA). They were all in accord with the young-Earth and anti-environmental positions held by CSAMA, and many were in fact taken verbatim from a document written by CSAMA members. A line-by-line comparison of the committee's draft 5 and the approved standards can be obtained at <http://www.kcfs.org/compare.html>. Those who would choose to take a public stand on this issue should at least take the time to actually read the two documents.

The Fordham Foundation, a respected conservative educational research institution, gave the standards passed by the Board the worst rating of any state in the country—a grade of "F" with a score of only 9 points out of 100. The Fordham report explained that the original standards document written by the 27-member committee "would have attained one of the highest ratings among the state standards reviewed." It then stated that "The State Board of Education gutted the document, removing almost every reference to the theoretical backbones of the sciences having historical content—astronomy, geology, and biology—and replacing some of the material with nonsense of a pseudoscientific bent."

In conclusion, I would warn evangelicals from grasping a conspiratorial view of the scientific and educational communities. Where individual scientists are promoting a naturalistic world view in the guise of science then challenge it, but support the vast majority of committed scientists and educators, many of whom are themselves committed believers, who have dedicated themselves to the scientific enterprise.

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On God and Suffering

Thank you for publishing David Holland's review of my book, *Big Bang, Small Voice: Reconciling Genesis and Modern Science* (*PSCF* 52, no. 2, [June 2000]: 132–3). He sets out the aims and contents of this very clearly. However, he says that I do not address "the issue of God and suffering." This is only partly true. I fully discuss the Fall (pp. 43–53, 102–3) and how this can be harmonized with science (pp. 104–5, 125–6). This deals with "natural" suffering. I discuss other kinds of suffering in my book, *God's Control Over the Universe: Providence and Judgment in Relation to Modern Science*, 2nd ed. (Caithness, Scotland: Whittles Publishing Services, 2000).

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

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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.

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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 Engineers and Scientists in Technology
Affiliation of Christian Geologists

b. Commissions

Bioethics
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Creation
Global Resources and Environment
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Physical Sciences
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Social Sciences

The symbol of trust

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 in science and related disciplines, who share a common fidelity to the Word of God and a commitment to integrity in the practice of science. Founded in 1941, the ASA has grown significantly since then. The ASA's stated purposes are: (1) "to investigate any area relating Christian faith and science" and (2) "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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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 on Science and Christian Faith* 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.

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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.

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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 or by contacting the ASA web site at: http://www.asa3.org or Canadian Scientific & Christian Affiliation, P.O. Box 40086, 75 King St. S., Waterloo, ON, Canada N2J 4V1 or by contacting the CSCA web site at: http://www.csca.ca

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A keyword-based on-line **subject index** is available on the ASA web site at: http://www.asa3.org

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

Volume 52, Number 3 **September 2000**