PERSPECTIVES on Science and Christian Faith

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In this issue . . .

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

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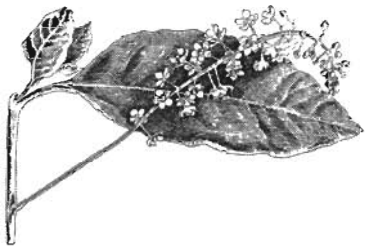

Pokeweed

Pest Purgation for Productive Pasture

Canadian Thistle

Sumac

The day was hot; the job was tough. My two daughters and I were working on a three-quarter acre neglected hillside pasture lot on a part of Shepherd's Knoll trying to purge three farming pests—pokeweed (*Phytolacca americana*), Canadian thistles (*Cirsium arvense*), and sumac (*Rhus typhina*) sprouts. Of special concern was pokeweed because the plant is a known toxin to agricultural animals. While our children have been taught not to sample the pretty but poisonous dark blue berries, sheep and calves are not so well trained! After some prolonged work, we removed the last traces of pokeweed and thistles. However hundreds of sumac sprouts varying from two to twenty feet in height still dominated much of the pasture. Looking at the growth, I decided that it was time to try a biological cure by buying some goats and putting them in this lot. As natural browsers, goats find tree sprouts to be delectable treats and typically prefer them above many pasture grasses. With the removal of the weed pests, bluegrass and fescue will thrive and the pasture will be much more productive.

My personal weeds of sin are not so readily removed. I frequently try to cover them. This hiding attempt provides the soil base for numerous new sin sprouts, rather than allowing the "hoe of the Lord" to remove the weedy root and thereby purifying the landscape of my heart. The apostle John writes: "If we confess our sins, he is faithful and just and will forgive us our sins and purify us from all unrighteousness" (1 John 1:9, NIV). May the Lord eradicate the weeds within me so that productive pasture grasses can grow.

We have an abundance of varied articles in this issue. Topics include ecology, theology, philosophy, molecular biology, biblical interpretation, creation, and history of science. The book reviews assist readers to discern which choices are most delectable to sample. I trust that you will not find any "weeds" in *PSCF*'s pasture, but only nutritional grasses.

May you experience jocund reading,
Roman J. Miller, editor

Earthkeeping and the Poor: Assessing the Environmental Sustainability of Development Projects

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Caring for creation is an integral part of development work among the poor. Development projects that rely directly on natural resources such as soil, water, plants, and animals for meeting basic human needs of clean drinking water, food, shelter, and livelihood must be environmentally sustainable if the benefits of the project are to be continued. Environmental assessment is one way of evaluating the sustainability of projects before implementation. This paper describes a six-step process suitable for small, community-based projects typical of Christian development agencies. An agriculture project in Uganda demonstrates an application of this process.

Humans have heavily impacted God's creation across the entire planet. Degradation is evident in polluted air and water, erosion of fertile soil, destruction of habitats, disappearance of plant and animal species, holes in the planet's ozone layer, and global climate change. These impacts originate in both the industrialized "North" and the developing "South," but the "South" bears an extra share of the consequences. The poor depend more directly on life-sustaining resources for meeting basic human needs—food, shelter, and livelihood. But in the struggle to meet these needs, resources are often degraded through excessive cultivation, inadequate sanitation, over-fishing, deforestation, and other forms of exploitation. Thus, people live with environmental stresses that can push them over the edge toward hunger and failing health, without socio-economic cushions. Poverty and environmental degradation are closely linked.

Development workers typically plan projects to use resources for the alleviation of poverty. Anticipation of the effects of development can be critical for long-term success of those actions focused on clean drinking water, increased food production, renewable energy sources such as wood, charcoal or biogas, forestry products, and other activities reliant on natural resources. These are more likely to be effective and less polluting if their potential environmental impacts are known and addressed.

Environmental assessment is one way of determining the effects of development projects. Broadly, this process identifies and evaluates environmental changes attributable to a particular project before implementation. Such assessment is typically applied to industrial mega-projects, but its basic framework and tools hold promise for assessing the sustainability of smaller, community-based projects. The results can be used to enhance such improvements as fuel-efficient wood stoves and to avoid or minimize adverse impacts, perhaps by redesigning the project with different technology or inputs, changing its location or timing, or other modifications.

For example, an environmental assessment of an oxen-restocking project was carried out in northern

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Uganda in 1998. The staff of the Christian Charity Center Uganda, a nongovernment development organization, and members of local communities participated in the assessment. Results showed that oxen-restocking improved soil fertility through the introduction of manure. Deeper tillage and burial of weeds decreased the need for burning. Higher income from increased yields reduced the pressure on local forests for other income sources such as charcoal production or firing of bricks. Adverse impacts included lower water quality at sites where oxen are watered from community water supplies, and increasing scarcity and fragmentation of land as demand for oxen-cultivated land increases. The environmental assessment suggested that the impact on water quality be mitigated through designating separate watering sites, and that land tenure follow a family system of land inheritance rather than the traditional practice of subdividing land for individuals. This example is examined in detail later.

All people are mandated by Scripture to care for creation, especially in their local areas (Gen 2:15, Lev. 25). Many Christian development agencies and their partners are aware of this, but may be poorly equipped and lack institutional capacity for implementation. In this paper,[1] environmental assessment is proposed as a tool for Christian development workers. It should not be viewed as obstructing development work, nor as elevating creation above human needs, but as enhancing development projects reliant on natural resources so that the poor benefit through improved food production, clean drinking water, available materials for shelter, and adequate livelihoods based on sustainable economic development. Environmental assessment can contribute to the provision of basic human needs and productive livelihoods through careful use and conservation of creation's resources.

This paper focuses on applying environmental assessment to small, community-based projects typical of Christian development agencies. It begins with a brief rationale, then describes a six-step process for assessment, followed by application to an agriculture project in Uganda.

Rationale for Environmental Assessment

There are at least three reasons why Christian development workers should apply environmental assessment. First and foremost, it demonstrates biblical earthkeeping.[2] The Bible calls all people to care for God's creation, fruitful and teeming with life (Gen. 1:22). This verse means to keep the earth with all its beauty, diversity, and abundance so that it reveals the Creator through evocation of human wonder and awe. A diverse, abundant creation gives evidence of God's providence, even as the Creator's bounty supplies resources needed for sustaining life, including ecological processes that replenish air and water, regenerate soil fertility, and reproduce plant and animal populations. A fruitful creation glorifies and praises its Creator (Ps. 104).

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A degraded creation hinders God's revelation, abuses his providence, and detracts from his praise.

As stewards, humans have a special place in creation, for the Creator entrusted it to humankind (Gen. 2:15). Humans may enjoy the fruits, but they should not destroy the fruitfulness of creation. Developing, using, conserving, or preserving resources must always occur within the framework of stewardship. This means caring in such a way that the Creator is revealed, life sustained, and God is praised.

Developing, using, conserving, or preserving resources must always occur within the framework of stewardship.

With humanity's fall, humans have not been faithful stewards and creation has suffered. All creation, along with people, longs to be redeemed (Rom. 8:21). Christians must actively participate in renewing and restoring the present creation in anticipation of a future creation that will be fully redeemed through Jesus Christ (Col. 1:20), a home to God and his people (Rev. 21:3). Stewardship is a call for Christians to care for the present earth in expectation of this homecoming. Environmental assessment is one way of responding to this call.

Secondly, environmental assessment can improve the effectiveness and efficiency of projects utilizing resources such as water, soil, trees, plants, animals, and fish. By considering ecological factors and processes, it can help ensure sustainability into the foreseeable future. Also, environmental assessment information may be used for evaluating technology options, selecting suitable sites, or setting harvest limits and schedules, thus avoiding costly and inappropriate technology, unsuitable locations, or overharvesting. The amount of time and money spent on environmental assessment is relatively small, and it is a wise investment in project sustainability.

Finally, environmental assessment can satisfy policy and legal requirements of partners or donors.[3] For example, Canadian federal law requires that all public funding of international development projects be subject to such assessment. This means that Christian agencies receiving Canadian funds for development work must conduct an environmental assessment and report its results to the government. Increasingly, governments in host countries also are requiring such reports. Malawi and Ghana, e.g., may require nongovernment organizations to assess their community projects as a condition for approval of water supply systems, health clinics, or farm inputs such as fertilizer and pesticides.

Some church and parachurch agencies have their own environmental policies promoting stewardship and assessment. Both World Vision Canada and the Christian Reformed World Relief Committee have environmental assessment policies and procedures with which overseas partners must comply. Agencies with this capacity are more likely to be viewed favorably by external partners, donors, and supporting constituencies. In summary, environmental assessment is a practical way of implementing the biblical call for earthkeeping, enhancing sustainability of projects reliant on natural resources, and strengthening relationships with those involved.

A Six-Step Process For Environmental Assessment

The focus of environmental assessment is typically on a future project so that potential changes may be anticipated. Information should be systematically collected, analyzed, and evaluated. A six-step process is proposed below, based on accepted environmental assessment practice at the screening level.[4]

Step 1: Describe the environmental setting

A succinct description of the project's surroundings is needed (Table 1). Possible sources of information include direct observation, local residents, environmental groups, government departments and universities, and international agencies such as the Food and Agriculture Organization and the World Wildlife Fund.

Step 2: Identify valued environmental components

Since no environmental assessment can study every aspect of the environment, a practical approach is to collect and analyze information only for relevant and valued environmental components (that is, natural resources or processes recognized as important in a community). Value may be determined by its utility for humans such as water for drinking, soil for farming, plants for medicine or its ecological

function or uniqueness, including wetland for water recharge and forest habitat for hunted game. One way of selecting valued environmental components is to identify resources or processes on which a proposed project would depend, or with which it may interact, for example, crop production depends on soil type and is influenced by erosion.

Only those environmental components with recognized specific value should be investigated further. Appropriate local information should be collected and measured such as quantity and quality of drinking water, depth of topsoil, and area of forest.

In this second step, indigenous values should be recognized. Nonwestern perceptions about environmental aspects may differ from those perceived in western cultures. For example, in Africa, monkeys often are considered agricultural pests, whereas termites, a pest in North America, are valued as food for fish ponds. These differences call for extensive local consultation. Since values are likely to vary among communities, and other stakeholders, these differences may lead to a wide range of valued environmental components that reflect various viewpoints.

Table 1. **Information Useful for Describing the Environmental Setting**

1. natural environment
- climate (annual rainfall patterns, flood & drought cycles)
- landscape (soil types, streams & lakes, ground water)
- biota (habitat types, endangered species)

2. resource use
- general land use
- agriculture (rainfed, shifting, irrigated) & inputs (fertilizer, pesticides)
- water sources (quantity & quality, collection & usage)
- energy (fuel sources, usage)
- forestry (products, tree planting)

3. community profile
- settlement (rural, urban)
- population & demographics
- occupations & labor pattern
- land tenure
- transportation
- sanitation facilities
- community organization & leadership

Step 3: Estimate changes in valued environmental components

Estimating potential future changes in valued environmental components is a challenging task. Three guidelines are suggested. First, the current baseline should be compared with two future environments: *the valued environmental components with, and without, the project.* It is necessary to distinguish between project-induced impact and natural variability. Change may occur naturally without a project. Impact occurs only if a project affects a valued environmental component. For example, a 200-hectare forest, valued for fuel wood, game and medicinal plants, may be reduced fifty hectares by land clearing associated with a proposed agriculture project. Without this activity, no change in forest area need be anticipated. Thus, a twenty-five percent decrease in forest area is a likely impact of this proposed project.

Second, although various methods for assessment have been developed, these usually require precise data and high level computers and expertise. Checklists and matrices do not necessarily require these. A checklist is a list of standard questions to be raised when assessing environmental

Table 2. **Sample Checklist for Assessment of Agriculture Projects**

Will this project:

- ☑ Result in more cultivable land or restore degraded land?
- ☑ Decrease the area of forest, grassland, wetland or other land types by land clearing, drainage or other form of surface disturbance?
- ☑ Directly affect soil fertility or soil erosion?
- ☑ Impact quantity or quality of water (surface and ground)?
- ☑ Affect natural drainage or water recharge areas (wetlands)?
- ☑ Use pesticides or fertilizers, especially in or near water?
- ☑ Destroy the habitat of valued animal or plant species (e.g., hunting, medicine, tourism)?
- ☑ Introduce exotic or non-local varieties of livestock or plants that may displace local varieties?
- ☑ Increase weeds, insects or disease vectors?

impacts (Table 2). A matrix involves a table showing interactions between valued environmental components and the project. A matrix is demonstrated in the Ugandan case below. Checklists and matrices provide a systematic process for estimating impacts, and are relatively easy to use.

Third, a particularly helpful way of collecting and analyzing environmental information is by means of participatory rapid appraisal. This involves semistructured techniques used in field work by a multidisciplinary team to provide quick, timely, and focused information (Table 3).[5] These methods are easily applied requiring minimal data, expertise, time, or technology and are well suited for community participation. Participatory rapid appraisal is already commonly employed by development agencies for collecting and analyzing social or economic data such as population, child health, and family income. Its familiarity offers considerable potential for estimating environmental impacts.

Step 4: Assess Significance of Environmental Changes

Once future changes have been estimated they must be evaluated, since impacts are not all equally important. Distinguishing the more important changes is known as significance assessment.

One approach to assessing significance involves criteria such as magnitude (size), duration (how long), timing (when, how often), location (where) or reversibility (permanent or temporary). Ultimately, however, value judgments about the acceptability of anticipated impacts are required. These judgments may be based on (1) earthkeeping norms (preserving fruitfulness or diversity), (2) environmental regulations (standards for pesticide use), (3) ecological uniqueness (preservation of rare or endangered species, with special areas or habitats), (4) human aspirations and needs (open space, medicinal plants), (5) distribution of impacts by gender or social groups (women, children, income level), and (6) aesthetics (visual quality).

Most importantly, communities affected by the project should participate fully in judging its acceptability. Local values should be incorporated in making judgments about anticipated environmental changes. Where local values clash with external ones, priority normally should be given to those people most directly affected. The way in which communities determine significance is also important. Indigenous decision-making processes should be respected and the outcomes usually supported.

Step 5: Determine project status

Results of significance assessment are used to determine the status of a project. Three possible outcomes are:

1. No significant adverse impacts are anticipated, and the project proceeds as planned,
2. Significant adverse impacts are anticipated, with avoidance or mitigation possible through project modification or implementation of preventative or restorative measures (Table 4), or
3. Significance of adverse impacts seems unacceptable or unknown, and a more comprehensive environmental assessment is required, or the project abandoned.

Table 3. **Participatory Rapid Appraisal Tools Useful for Rapid Assessment**

1. Direct observation
2. Interviews: group, semi-structured, key informants
3. Questionnaires
4. Transects
5. Diagrams: venn, flow, tree
6. Spatial analysis: resource maps, participatory maps, mobility maps
7. Time analysis: historical profiles, seasonal calendars, trend analysis
8. Matrix: scoring & ranking, pairwise comparison

Table 4. **Significant Adverse Impacts May Be Avoided or Mitigated By:**

- Relocating the project
- Altering the timing of project construction or operations
- Reducing the project's size or duration
- Implementing soil & water conservation measures
- Installing environmental technology
- Training personnel in environmental protection and management
- Compensating those impacted with another equal area for preservation

Step 6: Monitoring and Evaluation

Evaluation should include plans for regular monitoring during implementation. Monitoring is necessary to gauge the effectiveness of mitigation measures, to prepare for unanticipated environmental changes, and to strengthen the environmental baseline for similar projects planned elsewhere. Periodic evaluation is necessary to assess the long-term sustainability and to gain knowledge for new projects. This can be combined with normal monitoring and evaluation.

The above six steps of environmental assessment provide a systematic way to identify and assess the impacts of a proposed project on valued environmental components. For a project to be effective, this information must be integrated into the project cycle.

Integrating Assessment into the Project Cycle

Environmental assessment should be an integral component of decision-making, not a separate process. As such, it can provide timely, relevant information at various stages (Figure 1). Assessment must begin early, normally at the time of project conception. It is then that major decisions are usually made, sometimes irrevocably. Early consideration can influence site selection, future outcomes, and allocation of money, time, and personnel, thus avoiding costly delays or corrective action later.

Information on the environmental setting can be used to identify particular valued environmental components. More detailed data about each valued environmental component can be collected concurrently with community baseline surveys on health, food production, income, literacy, etc. Data on water, soils, plants, and wildlife can be easily integrated into the process.

Just as data from baseline surveys are used for need analyses, environmental information can help in estimating changes in valued environmental components attributable to a project. Environmental baselines also serve in assessing significance and in setting acceptable levels of environmental impact. For example, data about land use can help a community decide which watersheds may be cleared for lowland rice production and which must be preserved to ensure adequate stream flow for water supply.

Such information can be used to determine a project's status. Projects with no significant environmental impacts may proceed as planned. Where impacts are significant, the project design may be modified so that beneficial effects are enhanced and adverse impacts are avoided or minimized. Site, schedule, construction operations, or incorporation of environmental protection safeguards such as soil erosion control, tree planting, and the selection of an appropriate distance from a watercourse may be reconsidered. In cases where a project is not environmentally sustainable, overhaul or even cancellation may be warranted.

Monitoring can be integrated with regular activities. For instance, crop yields can easily be checked along with monitoring for changes in soil fertility, risk of erosion or areas of cleared land. Regular information collection can help manage any unforeseen impacts. Project evaluations should compare estimated to actual impacts, and appraise performance in collecting, reporting, and using environmental information. This feedback can provide valuable input for future planning and implementation, and for improving the environmental assessments thereof.

To summarize, the integration of environmental assessment into each stage of the project cycle is more likely to produce sustainable resource-based projects that achieve planned results over the long-term.

Case Study

Christian Charity Centre Uganda (CCCU) is a small non-governmental organization located in the town of Lira in Northern Uganda serving the dis-

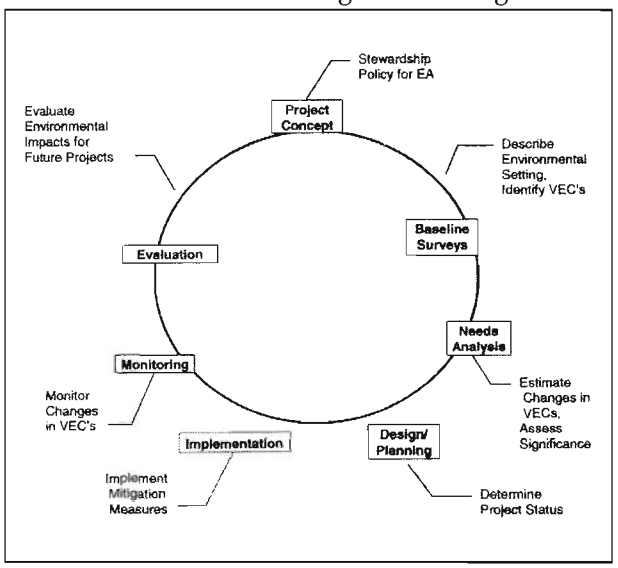

Fig. 1. Integrating Environmental Assessment (EA) into the Project Cycle. (VECs = Valued Environmental Components)

tricts of Lira and Apac. In 1997, CCCU commenced an oxen-restocking project in the Apac district following the eradication of oxen during an extended period of instability and violence.[6]

CCCU re-introduced oxen to increase food security and nutrition in the region, as well as to revitalize traditionally sustainable agriculture practices. Through a revolving loan scheme, pairs of farmers are able to purchase teams of oxen with one plough. CCCU provides training in oxen keeping and ploughing. Project results are very successful, farmers more than doubling their crop yields in a single season.

Despite its short-term results, long-term environmental sustainability has not been considered. Further, CCCU has a need to develop its capacity for applying environmental assessment to other future projects being considered for funding by its partners. Thus, an assessment of this oxen-restocking project would help evaluate its long-term sustainability as well as build the capacity for conducting environmental assessment elsewhere. Its assessment was therefore carried out in the fall of 1998, after about one year of operation. This evaluation of an existing, rather than planned, project was justified by uncertainties about long-term viability and concomitant provision of training for future projects. Atar, the first village to receive oxen, was selected as a representative site to limit the scope of the environmental assessment.

Approach

Community participation was critical. Project beneficiaries were consulted through a community meeting and informal interviews. Techniques of participatory rural appraisal, including community mapping, farm sketches and trend lines, were used to collect and record information about the local setting.

Assessment began with a community meeting at which the team was formally introduced and the environmental assessment process explained. The team used a mapping exercise where community members drew, on bare ground, a map of their parish showing key environmental features such as water sources, grazing land, vegetation types, roads, wetlands and sites exhibiting environmental degradation (Figure 2).

Rapid appraisal techniques were also used in meetings with individuals. They were asked to draw trend lines representing change in environmental or community components such as soil erosion and population growth. Sketching was also employed to record information about their farms. In addition, information was gathered from individual oxen owners, using informal interviews. These techniques facilitated community involvement and provided a record of the environmental setting, raising awareness and identifying concerns about the local environment.

Information gathered from the community and individuals was used to refine the general list of valued environmental components initially prepared by the assessment team. This list included soils, erosion, vegetation, animals, water, farming practices, land tenure system, and energy. Additional valued environmental components identified as valuable by the community included termites, burning, bees, market, family size, education, and seed quality. Thus, the selected valued environmental components represented values from the community and the assessment team.

Results

Once chosen, the assessment team estimated impact on each valued environmental component. These were arranged into a matrix for impact analysis and significance assessment (Table 5). Each was analyzed for any change attributable to the project, whether negative, positive or neutral in impact. The significance of any impact was assessed for each valued environmental component and ranked on a scale ranging from 0 to 5 (0 = no impact; 5 = severe or permanent impact). Degree of confidence in analysis and assessment were also ranked to incorporate uncertainties among the assessors, with 1 as unknown and 5 as positively known.

The overall impact of the Apac oxen-restocking project was evaluated as positive (Table 5). Most of the environmental parameters were decidedly positive in impact. The oxen-restocking project, with its introduction of sustainable agricultural practices largely benefitted the local environment. Increased soil fertility was particularly evident with the introduction of manure. Earlier, deeper tillage and the burying of weeds reduced the need for burning. Increased crop yields and improved food security decreased pressure on local forests for income generating activities such as charcoal burning and brick-firing. Training in agroforestry and tree nursery establishment was also incorporated into the training for oxen ploughing. This training as well as more general environmental education contributed significantly to the environmentally positive impacts of the project.

Only a few adverse impacts stand out. Water quality has decreased in some sites where community water supplies are also used for watering oxen. Also, the land tenure system may be adversely affected because landowners anticipate increasing land scarcity and greater fragmentation of their holdings, as oxen cultivate more patches.

The threats to water quality and land tenure may be mitigated through measures that can avoid, minimize or correct. Changes to water quality can be minimized by designating some watering sites exclusively for oxen, supported by an education campaign on water sanitation. An option being considered by CCCU for mitigating the adverse effects

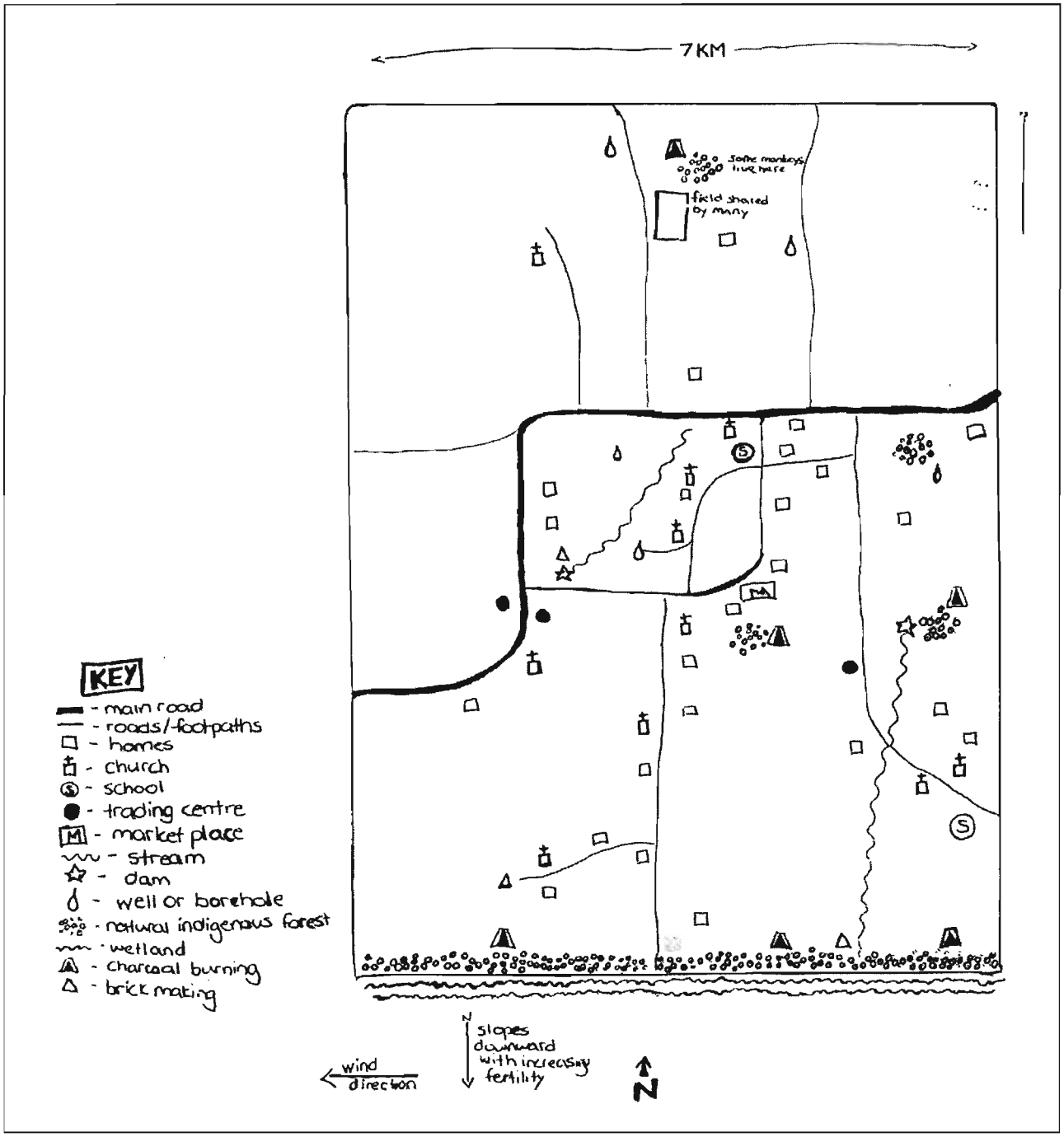

Figure 2. Community Mapping for Oxen Re-Introduction Project in Abedi Parish, Uganda.

of the project on land tenure and use is to encourage the allocation of inherited land parcels jointly to family members for their collective use, rather than following the traditional practice of dividing land into segments for individual inheritance.

Monitoring and evaluation of environmental impacts have been integrated into the project cycle. For example, CCCU will monitor soil fertility along with crop yields on a regular basis. Monitoring of key valued environmental components is needed to assess mitigation measures and watch for unexpected impacts. Monitoring data are useful for comparing estimated and actual impacts of the project, and for conducting assessments in the future.

Lessons Learned

Several lessons have been learned from the application of environmental assessment to oxen

Table 5. **Environmental Impact Matrix for Oxen Re-Introduction Project**

Environmental Parameter	Impact	Significance	Confidence	Key concerns
Soil	+	3	3	Burying weeds and manure resource, deeper tilling mobilizes nutrients, soil more loose and permeable
Erosion	+	1	3	Clearing of natural vegetation decreases cover, education on erosion prevention, high adoption of contour planting, increase in tree planting
Vegetation	+	1	4	Decrease in natural vegetation as more land cleared tree planting emphasized, weed control through early ploughing
Animals	+	2	4	Decrease and fragmentation of habitat as a result of land clearing, beneficial with respect to pests, direct re-introduction of oxen
Water	-	2	3	Slight increase in water scarcity as watering site required for oxen, erosion prevention training, introduction of chemical pesticides, increase in animal waste, increase in cleared land
Farming Practices	+	4	4	Increase in cultivable land, increase in productivity, encourages diversity maintenance of fallow practices, training in best agricultural practices, integration of agroforestry, decrease in labor
Land Tenure	-	4	4	Loss of land for cropping, increase in fragmentation, Increase in land conflicts, planting outside ownership boundaries
Energy	+	4	4	Decrease in charcoal and brick production as a result of higher income
Termites	-	3	2	Increase in cleared land, increase in young trees
Burning	+	4	3	Early ploughing minimizes need to burn to clear, education and sensitization
Bees	+	3	3	Encourage modern bee-keeping, reduces cutting trees for wild bees
Family Size	+	3	3	Encourage family planning, increase in educated children
Education	+	4	4	Increase in family income allows more children to attend school
Seed Quality	+	4	4	Increase in income allows purchase of better seeds, new, improved seeds introduced

Key:

Impact:
+ = positive
\ = neutral
- = negative

Significance:
0 = no impact
1 = negligible impact
2 = minor, slight, short term
3 = moderate impact
4 = major, irreversible or long term
5 = severe, permanent impact

Confidence:
1 = unknown
2 = uncertain, unsure
3 = quite certain, confident
4 = very certain, confident
5 = positive

restocking. The case study demonstrates that environmental assessment can provide important information for a project. Information about soil fertility, water sources, and land tenure is useful for managing the project toward long-term sustainability. Another valuable source of information is the environmental baseline, potentially useful for monitoring positive and adverse environmental impacts of any project.

While the staff of CCCU has been enabled to evaluate the long-term environmental sustainability of the oxen re-introduction project, the benefits reach much further. Training in the methodology and practice of environmental assessment can now be extended to other projects. Staff participation has stimulated environmental awareness, so this is now considered in other projects. Overall, it has improved the capacity of CCCU to promote and implement projects that are more likely to be environmentally sustainable.

A shortcoming in this case is that the environmental assessment occurred during the operational phase. Ideally, it should have begun earlier in the project cycle. Despite poor timing, CCCU was still able to identify impacts and to address them through mitigation and monitoring. While we hope this is not the norm, it does show that an environmental assessment of an existing project can improve an ongoing operation, making it more tangible than a planned one and thus appropriate for training purposes.

Notwithstanding its timing, this case also illustrates that environmental assessment can be integrated into the project cycle, enabling each component to be linked to specific steps in the process. In the oxen project, an environmental baseline now exists for integration with the community baseline, and its monitoring and evaluation are being adapted to include valued environmental components. Integration of environmental assessment into the project cycle provides a holistic approach to managing long-term sustainability.

All people are called to exercise stewardship of God's creation. The poor, too, long to respond to this call in their locales. Christian development workers have an obligation to enable this calling to be filled. Environmental assessment is a practical way of demonstrating the Christian calling to be caretakers of creation in the service of the poor. ⁂

Notes

[1] Research for this paper received financial support from the PEW Charitable Trusts through the Council of Christian Colleges and Universities, Social Sciences and Humanities Research Council of Canada, and World Vision Canada. Two reviewers provided positive suggestions.

[2] For more detailed biblical perspectives on caring for creation see C. DeWitt, *Earth-wise: A Biblical Response to Environmental Issues* (Grand Rapids, MI: CRC Publications, 1994); W. Granberg-Michaelson, *Tending the Earth: Essays on the Gospel and the Earth* (Grand Rapids: Eerdmans, 1987); F. Van Dyke, et al., *Redeeming Creation: The Biblical Basis for Environmental Stewardship* (Downers Grove, IL: InterVarsity Press, 1996); L. Wilkinson, *Earthkeeping in the 90s: Stewardship of Creation* (Grand Rapids: Eerdmans, 1980). Resources that link caring for creation and the poor include D. Hallman, *Ecotheology: Voices from South and North* (Geneva: WWC Publications, 1994); C. DeWitt and G. T. Prance, eds., *Missionary Earthkeeping* (Macon, GA: Mercer University Press, 1992); W. D. Roberts and P. E. Pretiz, eds., *Down-to-Earth Christianity: Creation-Care in Ministry* (Wynnewood, PA: Association of Evangelical Relief and Development Organizations, and Evangelical Environmental Network, 2000).

[3] The idea of environmental assessment originated with the U.S. National Environmental Policy Act in 1969. Most countries now have environmental assessment laws or policies, although progress in the South has been hampered by a perceived priority of human need over environmental concerns and the lack of institutional capacity for environmental assessment. However, these issues are being addressed by the increasing awareness of the link between poverty and the environment, and by establishing administrative units, staff and procedures for environmental assessment. See Lee Norman and Clive George, *Environmental Assessment in Developing and Transitional Countries* (Chichester, England: John Wiley & Sons, 2000).

[4] Environmental assessment may be completed at various levels of sophistication depending on the complexity of the proposed project and its environmental sensitivity. Screening level EA is the most basic. It is designed for rapid appraisal of impacts from small projects unlikely to have major impacts. Other, more comprehensive forms of environmental assessment, normally require detailed scientific study by experts and are usually subject to public and regulatory review. Resources on screening level environmental assessment include Canadian International Development Agency, *Handbook on Environmental Assessment of Non-Governmental Organizations and Institutions Programs and Programs* (Ottawa: Canadian Partnership Branch, Canadian International Development Agency, 1997); Dean Pallen, *Environmental Assessment Manual for Community Development Projects* (Ottawa: Asia Branch, Canadian International Development Agency, 1996).

[5] National Environment Secretariat, *Participatory Rural Appraisal Handbook: Conducting PRAs in Kenya* (Washington, DC: World Resources Institute, 1991).

[6] This environmental assessment was carried out by Janelle Zwier as part of her internship in Environmental Studies at The King's University College. It was completed for the Christian Reformed World Relief Committee (CRWRC) and its partner Christian Charity Centre Uganda (CCCU) in the community of Apac during late 1998.

In Favor of God-of-the-Gaps Reasoning

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It is passe to reject "God-of-the-gaps" arguments, but I argue that it is perfectly reasonable to argue against atheism based on its lack of explanatory power. The standard argument against God-of-the-gaps reasoning deviates from the mode of normal scientific discourse, it assumes a view of history which is incorrect, and it tacitly implies a naive optimism about the abilities of science. I encourage apologists to point out gaps of explanation in atheistic theories wherever they see them, and expect atheists to return the favor.

For more than fifteen years, I have read the ASA journal and participated in discussions of science and Christianity. During this time, I have found that while ASA members disagree over many things, certain unquestioned points of agreement flow through all of our discussions. In particular, I have found that no matter what the topic, one common premise seems to reign supreme. This is the universal condemnation of God-of-the-gaps arguments.[1] A person might present all manner of impressive reasoning about something, but if his opponent says "that is a God-of-the-gaps argument," even the stoutest evidentialist wavers. Why is this so? In this communication, I wish to take a heretical position within the ASA and argue in favor of God-of-the-gaps arguments.

The anti-God-of-the-gaps (AGOG) position, for those who may not have moved in ASA circles long enough, goes essentially as follows. In the past, people argued for the existence of God on the basis of the lack of other explanations for things, that is, "gaps" in our understanding. As science has progressed, many of these things have been explained by science without the need to invoke God's existence. Consequently, the size and number of gaps where one may hide God have shrunk. Thus, we must not argue for the existence of God on the basis of the failure of the atheistic world view to explain things, lest we eventually have no gaps in which to hide God.

*ASA Member

Three Objections to Anti-God-of-the-Gaps Arguments

1. Normal Rules of Evidential Discourse

On the surface, the AGOG position seems strange when viewed from the perspective of normal scientific discourse. In deciding between two competing theories, we are told at the outset that we must not take into account the failure of one of the theories to explain things. Why not? It is perfectly normal in scientific discourse to point out the weaknesses of theories and to argue against them on the basis of their failures to explain things. If a theory fails to explain something, that does not necessarily mean it is false, but most scientists feel that too many unexplained mysteries substantially weaken the case for a theory.

Let us consider a typical example from science. In my scientific research, I often have discussions in which I propose a model for some system, for example, that a spectral line can be understood as arising from a certain type of electron motion. If another scientist calls my theory into question by pointing out a failure of explanation, I can imagine the following conversation:

Me: I think the electrons move coherently. The wavelength of this spectral line agrees with my calculation.

Colleague: But if that is true, shouldn't the energy of that second line also agree with your calculation?

Me: You are pointing out a gap of explanation in my theory. That is a "gaps" argument; therefore, it is invalid.

If I acted this way, I would not survive long in academia. Rather, I try to explain the data within my model and if I cannot, I feel I have lost a point in the argument. Yet, this is how AGOG proponents often argue:

Scientist 1: I think that all of life can be explained by random variations of molecules without invoking God. The fact that urea can be created by random processes agrees with my view.

Scientist 2: But if that is the case, shouldn't there also be random generation of DNA? How do you explain the existence of DNA?

Scientist 1: That is a God-of-the-gaps argument; therefore, it is invalid.

Of particular interest to the ASA are two rival theories before us. One says that the most fundamental ground of the universe is personal, that there is a God. The other says that the ground of the universe is impersonal, that there is no God. Do we not want to judge between these two theories based on their explanatory power? Atheists seem to have no qualms with pointing out "gaps" in the theistic theory, for example, the apparent failure to explain evil or the silence of God. Why should we not point out the failures of the atheistic theory to explain things, such as the apparent design of life and the universe or the nearly-universal desire among people to worship something?

I am being deliberately vague about what constitutes an "explanation." Many philosophers have dealt with this question without agreement; clearly, an explanation that satisfies one person may not work for another person. At the most basic level, an explanation is a story that satisfies the hearer, for whatever reason. Within various groups of people, there are common criteria of what makes a satisfying story, which is why I can and often do convince other scientists to change their minds and accept my explanations of things like spectral lines. To some people, only mathematical equations make a satisfying story; to other people, only teleological "why" explanations are satisfying; perhaps some people only like stories with happy endings.[2] If another person has different criteria for what makes a satisfying explanation, I will have difficulty convincing him or her of my theory.

What surprises me is that many Christian apologists reject all attempts to discuss failures of explanation, even in areas where all parties *do* share a common standard of explanation. If I point out the failure of the atheistic theory to explain some aspect of design within its own framework, and my opponent does not accept my teleological God-explanation on the grounds that God-explanations are not explanations, we can still agree that the atheistic theory has failed on its own terms on this point, and that this failure constitutes a weakness.

Lack of explanation can weaken a theory even when no acceptable rival theory seems available. Sometimes when too many unexplained entities build up, a previously unacceptable theory can become acceptable, in a Kuhnian "revolution." For example, no one rushed to accept Einstein's Theory of Relativity at the beginning of the twentieth century. Yet, even those who rejected the theory had to admit that the Michelson-Moreley experiment lacked explanation within their frameworks. More recently, the Alvarez theory of the extinction of the dinosaurs by meteor impact has not received universal acceptance, but the thin layer of iridium found in similar geological layers around the world has put opponents on the defensive; it seems to demand explanation.

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Some people have said that arguing *against* a theory does not argue *for* another theory; therefore pointing out gaps in atheistic thought does not support theism. This is silly. Certainly this is not the way science normally works. People arguing over scientific theories call to attention the explanatory failures of rival theories all the time, and everyone accepts this as proper argumentation. If a theory is perceived to have many failures, alternative theories are strengthened.

Therefore, my first objection to the AGOG position is simply that it violates the normal rules of evidential discourse, in which people often point out the unexplained entities in each other's theories. Of course, some people reject evidentialism, arguing that we should presuppose certain theories whether or not they explain anything. I have argued for evidentialism previously,[3] but even if one rejects evidentialism, one can hardly call the entire evidentialist program irrational or naive, since all normal scientific discourse is evidential discourse.

2. A False Premise about History

As I have previously discussed,[4] one reason why people want to reject evidentialism in religion is the underlying belief that if they looked at the evidence seriously, they would lose the argument. Anti-evidentialism is essentially a shell-shocked defensive position. This brings me to my second objection to the AGOG position. Although I am not a historian, I believe it is worth asking whether the premise of the AGOG position is historically valid. What specific gaps did people formerly use to argue for the existence of God, which atheistic science now explains? I can think of some triumphs of explanation in science, such as Maxwell's equations that explained the mysteries of magnets and prisms, or the Copernican/Newtonian theory that explained the orbits of the planets and comets. Did anyone ever argue for the existence of God because we did not understand magnets or the orbits of the planets? Perhaps some pagan shaman somewhere has argued that way, but I see no evidence for any serious Christian argument along these lines.

We must distinguish between bad explanations for certain things *within* the theistic world view, and arguments for the theistic world view itself. People arguing that comets were signs from God or that demons caused all sickness did not argue that God *existed* because comets and demons existed. Rather, starting from a belief in God, they posited a reasonable, though ultimately falsified, theory about comets and demons. In the same way, people working within an atheistic world view have proposed bad explanations for things, such as the theory of spontaneous generation or the Lamarkian theory of evolution. The falsification of a subtheory within a larger world view does not falsify the whole world view. If it did, every falsified scientific theory would cause everyone to reject all of Western science.

Having read many of the apologetic tomes of the past two thousand years, I see three lines of argument for the existence of God. One line, typified by Aquinas, has argued for the existence of God on the basis of fundamental aspects of the universe such as causality and change. Another line, typified by Paley, has argued that the hand of God is evident in the apparent design of the universe. A third line, typified by Calvin, has argued that God makes himself evident in personal transcendent experiences of people. Has any of these lines of argument been seriously challenged by the successes of science?

The first line of argument received its greatest challenge not from science, but from philosophers such as Kant, who argued essentially that this line of thought does not provide airtight deductive proofs, but instead reduces to evidential arguments on the basis of general experience. As such, these arguments remain as powerful today as ever before, with the same limitations.

Part of the appeal of the AGOG position is the sense of progress marching on, removing one Christian evidential apologetic argument after another. ... However, this past history does not exist.

The second line received its challenge from Darwinism, and the last line received its challenge from Marx and Freud. These challenges provided explanations for apparent design and religious experience within the framework of the atheist world view. Yet, more than a century later, these explanations still remain under debate, involving some of the things that we understand the least in science—chemical evolution and the brain. Some people may say that these explanations are beyond doubt, but they cannot argue that these theories come on the heels of numerous other scientific theories that overturned prior Christian arguments for the existence of God. Christians used to argue for the existence of God on the basis of apparent design and religious

experience, and they still argue for the existence of God on the basis of apparent design and religious experience. In other words, part of the appeal of the AGOG position is the sense of progress marching on, removing one Christian evidential apologetic argument after another. Present gaps in evolutionary or Freudian theory can be ignored in light of this track record of success. However, this past history does not exist. Atheistic filling of gaps begins and ends with its attempts to explain apparent design and religious experience in the context of Darwinism and psychology.

In the most notable examples of apparent filling of gaps, the discovery of DNA and the nuclear theory, the new gaps created by their filling are actually worse than the previous gaps.

Within the framework of Darwinism, has there been that long, steady march of reducing gaps? Let me discuss two examples. In the nineteenth century, two gaps caused problems for Darwinists. First, they had no explanation for the mechanism of transmission of traits from one generation to the next. Second, they had no answer to Lord Kelvin's argument that the earth could not be old enough to allow random variations to produce all the apparent design we see, because simple physical arguments showed that the sun could not burn for millions of years.

In the middle of the twentieth century, two scientific breakthroughs occurred, which seemed to solve these problems. Watson and Crick discovered DNA, and the nuclear theory of Bethe showed that stars could burn for millions of years using nuclear fusion. These discoveries apparently filled the gaps with resounding success. Yet within twenty years, both discoveries had raised as many problems as they had solved.

Since the discovery of DNA, scientists have learned that the information stored in DNA is vast. No one today has an adequate explanation for how this highly complicated molecule arose out of nowhere. Also, we do not have an adequate explanation within chemical evolutionary theory for the appearance of the mechanism that gives us a readout of the information, or for the appearance of methods that replicate information without error, or for the appearance of the delicate balance of repair and maintenance of the molecular systems that use the information stored in DNA.[5]

The nuclear theory of Bethe showed that stars could burn for millions of years, consistent with the geological record. Yet this nuclear theory had strong implications for cosmology. Many scientists, starting in the 1960s, only a few years after Bethe's work, showed that in order for the stars to burn as long as they do, certain exquisite balances must exist in the fundamental constants of the universe, the now-famous "large numbers coincidences."[6] Various efforts to explain these coincidences have been made, such as many-worlds and inflation theory.[7] Each endeavor so far has the status of a framework for attempting an explanation, not an explanation. Few scientists would say that these theories resolve the problems.

Books by people like Behe,[8] Johnson,[9] Dembski,[10] and Ross[11] have raised serious scientific issues in pointing out the gaps in atheistic evolutionary and cosmological theory. A frequent response to these books is that they have followed an improper mode of discourse, because pointing out gaps is illegitimate. Yet if a reason to reject a gaps argument is the past track record of a steady closing of gaps, it stands to reason to ask when that steady closing of gaps has occurred. In the most notable examples of apparent filling of gaps, the discovery of DNA and the nuclear theory, the new gaps created by their filling are actually worse than the previous gaps.

The design of the universe is just as apparent now as it was in the sixteenth century, or in the first, when Paul wrote: "For since the creation of the world God's invisible qualities—his eternal power and divine nature—have been clearly seen, being understood from what has been made" (Rom. 1:20). Design is obvious at a glance to anyone, and detailed scientific analysis has not changed that fact.

3. Naive Optimism

My last objection to the AGOG position is that it implicitly relies on a naive optimism about the future of science. It reeks of nineteenth-century rationalism and postmillennialism in assuming that the onward steady march of science explains and solves everything. If the twentieth century has taught us anything, it is to be suspicious of those who put all their hope in science as the explainer of everything.

Suppose that my historical criticism above is false, and that actually many Christian apologists in the past have used failures of scientific explanation for things like magnets and comets to argue for the

existence of God, and that science has defeated them at every turn. Does it follow that science must inexorably press on to defeat *every* evidential Christian argument? Perhaps we have lived through a short period of very foolish Christian apologists. Nevertheless, we must still ask whether the failures at explanation before us now, the gaps in the atheistic theory, seem likely to be filled by science. For example, suppose a short-sighted person at the beginning of the twentieth century said that no one can make a building fifty stories high. In a few years, this barrier is passed. Then the person says that, well, no one can make a building one hundred stories high. Science soon makes this possible, too. Then the person says that no one can make a building two hundred stories tall. Does it follow from the track record that science will soon make it possible to have buildings 200, 400, and 800 stories tall, that there is no upper bound to the ability of science to make tall buildings? The failure of naive pessimism does not imply unbridled optimism.

In the twentieth century, we have seen the speeds of cars, the range of humans in rockets, and the height of buildings increase rapidly, only to stop at a natural level. In the nineteenth century, a person might have felt that the speed of sailing ships had no upper bound. Perhaps we are all still enamored with the rapid progress which occurs when a new field is opened, forgetting that science does have limits, even if those limits are higher than we first thought. By the same logic, a Westerner might travel to a remote tribe in South America, show them magnets, penicillin, and radio communication, and after this impressive display, say, "You see that I can do *anything*. I am all-powerful."

Another Version of the AGOG Position

Perhaps some will object that I have distorted the AGOG position in the above discussion. One might give a slightly different version of the AGOG position by arguing that, while it is proper to point out failures of explanation of the atheistic world view generally, it is not proper to point out failures of evolutionary science, because evolutionary science is good science and all good science can be incorporated into the Christian world view. I agree that Christians should value all good science, and in general, failure of science per se to explain things does not support theism. If neither of two theories has an explanation for a given gap, then this cannot count as evidence for either theory. In my prior example of the debate with a colleague about spectral lines, if neither of us can explain the second spectral line, then we both simply have to admit weakness. Similarly, if neither theist nor atheist scientists can explain magnets, this lack points us neither toward nor away from God.

If one theory makes a successful prediction that the other cannot explain, however, this counts as evidence against the theory which cannot explain it. Both theism and atheism are theories that make falsifiable predictions about things we should see in the realm of science. Specifically, the atheist theory predicts that we should find a mechanism by which all life could have arisen as the result of many simple, uncorrelated causes; Christianity says that the world is explained by a unifying Purpose, and expects that the hand of God should be evident in the world around us (Rom. 1:20).

[Some people might argue] that, while it is proper to point out failures of explanation of the atheistic world view generally, it is not proper to point out failures of evolutionary science, because evolutionary science is good science and all good science can be incorporated into the Christian world view.

How do we expect to see God in the world? I can imagine three possible predictions: (1) we might expect to see exquisite design and balance in the framework of life and the universe; (2) we might expect that many people would have the experience of communing with God; and (3) we might expect many daily, direct, miraculous communications from God. Scientific analysis of our experience seems to falsify the third prediction, which forces a revision of the theory (as is natural in the scientific method) to allow that God may have decided to limit miraculous communications to a few people at a few times. Perhaps, given enough time, science will invalidate the first prediction, too. Is there any reason to preemptively capitulate on this point, however? Do we expect that God should leave *no* fingerprints in the universe?

The present "gap" in the atheistic theory comes from a successful prediction of the theistic theory, that we should expect evidence for exquisite fine-tuning and apparent design. If this observation has no adequate explanation in the atheistic theory, it

must count as a weakness relative to theism. On the other hand, successful demonstration that the observed design is *probable* starting with known simple, uncorrelated causes counts as evidence for atheism. Perhaps we will find some day that God has decided to create all design in this way, via a "fully competent creation," leaving only the second type of evidence listed above, personal experience. If so, the probable random generation of apparent design would count as a successful prediction of atheism with only a weak theistic explanation, that is, a "gap" in the theistic theory, and would be used triumphantly as such by all atheists.

Failures of evolution per se do not necessarily argue against atheism. Many Christians embrace some model of theistic evolution. Evidence for animals changing their forms, an earth millions of years old, or common aspects of animals and humans does not intrinsically support either atheism or theism. However, a successful demonstration that all the design we see can have occurred entirely through uncorrelated, simple causes would count as a successful prediction of the atheist theory. Even a theistic evolutionary model naturally leads to the prediction that the overall system will exhibit fine-tuning which is not explicable within the atheistic world view.

Is the AGOG Position Fearful of Falsifiable Predictions?

I specifically included a falsified prediction in the above list, the expectation of many miraculous communications from God, because so many theistic apologists seem to be afraid of making falsifiable predictions. We seem to have the attitude that one falsified prediction will cause the whole theistic framework to come crashing down, so therefore we better not make any predictions. Science does not work that way, and neither should apologists. A falsified prediction often forces a revision of a theory without rejection of the whole framework. Christians must have the humility to revise their theology, thus maturing their understanding without discarding their entire framework.

Lord Kelvin strongly argued that the sun could not have the age of millions of years required by evolutionists, implying the prediction that the earth and sun should look relatively young. This prediction has been falsified; yet, the falsification led to greater problems for the atheist world view. Should Kelvin have never argued as he did? In the same way, it is perfectly reasonable for young-earth creationists to have made the falsifiable prediction that the earth should look young. The problem today is that they seem to be unable to acknowledge that the data long ago falsified that prediction; there are too many gaps of explanation in Flood Geology. In refusing to admit this, Flood geologists are no different from some secular physicists I have known who refuse to admit that their theories have failed, clinging to tenuous explanations of the data rather than admitting the obvious. Science becomes pseudoscience when the sponsors of a theory refuse to admit a falsification and force all facts into conformity with their theory. It is *not* pseudoscience if they base their predictions on their interpretations of the Bible (or, for that matter, if they base their predictions on Peanuts cartoons), *if* they are willing to admit a falsified prediction under normal standards of evidence.

A falsified prediction often forces a revision of a theory without rejection of the whole framework. Christians must have the humility to revise their theology, thus maturing their understanding without discarding their entire framework.

Some people have asked me, "What if a new scientific result comes along next year which explains all the large-numbers coincidences as the work of uncorrelated, simple natural forces? Where would you be then?" Of course this would weaken my evidential argument, but I do not lose sleep over that possibility. By the same token, one can ask, "What if a new scientific result comes along next year which proves Flood Geology and Young-Earth Creationism?" No one can prove this will not happen, but I doubt it. In either case, one is hypothesizing a completely unknown scientific theory on bare faith. I do not know why I should expect the large-numbers-coincidence gap to be filled before the Flood Geology gap.

Perhaps God has not given us evidence of design in nature, and has made all things to appear as if they arose with no design or fine-tuning. After all, God does not need to give us all the evidence we may want, as we see in the fact that he does not generally speak miraculously to the public, or write "GOD MADE ME" in English on the side of every

cow. Yet I can think of no a priori reason to rule out the possibility that he has put observable fine-tuning into nature, and that if we see such, that we should point out this fact to atheists.

As in many theoretical debates, certain data may weaken one theory but lend support to more than one alternative theory. Not only Christianity, but also Deism, Islam, and New Age theories may find support in evidence of design and fine-tuning. That is well and good; other evidence will have to distinguish between these theories. In the scientific world, no one complains if an observation eliminates only one of several theoretical possibilities.

Let us therefore happily point out the gaps in atheistic science, while also admitting the gaps in our own explanations if such arise. To paraphrase a trite old saying, "Better to have predicted and lost than never to have predicted at all." ⁂

Notes

[1]E.g., D. F. Siemens, Jr., *Perspectives on Science and Christian Faith* 49 (1997): 196; W. R. Hearn, *Being a Christian in Science* (Downers Grove, IL: IVP, 1997), 75; W. Christopher Stewart, *Reason For the Hope Within*, M. J. Murray, ed. (Grand Rapids, MI: Eerdmans, 1999), 321.

[2]One may distinguish between "trivial" and "nontrivial" explanations, however, by their degree of predictiveness. The trivial explanation, "It is that way just because God wants it to be that way," has no gaps of explanation but is not too helpful as a predictive theory. Some opponents argue that all theistic theories of design and purpose in nature are like this and therefore are fatal to science. I can see no intrinsic reason why this must be the case. One could equally well propose a trivial atheistic explanation of everything, "It's that way just because it is." (Or, "just because evolution made it that way.") A theory of design can in principle be predictive and quantitative. For example, a computer-chip manufacturer which takes apart a chip made by a rival company proceeds on the assumption that the circuits are well designed; this does not lead them to end their investigation, but rather, drives their study of the chip. The good-design assumption leads to specific predictions and applications, e.g., the prediction that it is unlikely to find wires that waste metal and take up space but serve no purpose, so that there should be few wires which are dead ends, with the application that studying any particular wire is likely to be useful. A bad-design assumption (e.g., that the chipmaker made many random circuits and then just picked out the ones that worked) would give very different predictions.

[3]D. Snoke, "The Problem of the Absolute in Evidential Epistemology," *Perspectives on Science and Christian Faith* 47 (March 1995): 2–22, 3.

[4]Ibid.; and D. Snoke, "Toward a Unified View of Science and Theology," *Perspectives on Science and Christian Faith* 43 (September 1991): 166–73, 166.

[5]M. J. Behe, *Darwin's Black Box: The Biochemical Challenge to Evolution* (New York: Free Press, 1996); R. Shapiro, *Origins: A Skeptic's Guide to the Creation of Life on Earth* (Summit Books, 1986); J. D. Barrow and F. Tipler, *The Anthropic Cosmological Principle* (Oxford: Oxford University Press, 1987), 565; P. Johnson, *Darwin on Trial* (Downers Grove, IL: IVP, 1991); J. Horgan, "In the Beginning," *Scientific American* (February 1991): 100–9, 100; and John Leslie, "Cosmology, Probability, and the Need to Explain Life," in *Scientific Explanation and Understanding*, N. Rescher, ed. (Pittsburgh, PA: University of Pittsburgh, Center for Philosophy of Science, 1983), 53–82.

[6]P. C. W. Davies, *The Accidental Universe* (Cambridge: Cambridge University Press, 1982); J. D. Barrow and F. Tipler, *The Anthropic Cosmological Principle*, 408–12; and R. Collins, "A Scientific Argument for the Existence of God: The Fine-Tuning Design Argument," in *Reason for the Hope Within*, M. J. Murray, ed. (Grand Rapids, MI: Eerdmans, 1999), 47–75.

[7]D. Snoke, "The Apologetic Argument," *Perspectives on Science and Christian Faith* 50 (June 1998): 108–21, 108.

[8]M. J. Behe, *Darwin's Black Box*.

[9]P. Johnson, *Darwin on Trial*.

[10]W. A. Dembski, ed., *Mere Creation* (Downers Grove, IL: IVP, 1998).

[11]H. Ross, *The Fingerprint of God*, 2d ed. (Orange, CA: Promise, 1991).

Upcoming ASA Annual Meetings

Aug. 2–5, 2002: Pepperdine University, Malibu, CA
"Christian Pioneers in Science"
Program Co-chairs: Ted Davis, Sara Miles
Local Arrangements Chair: Stanley Moore

July 25–28, 2003: Colorado Christian University, Lakewood, CO
Theme: Cosmology
Program Chair: Jennifer Wiseman
Local Arrangements Chair: David Oakley

July 23–26, 2004: Trinity Western University, Langley, BC Canada
Theme: Neuroscience
Canadian Program Chair: Heather Looy
Local Arrangements Chair: Judith Toronchuk

Aug. 5–8, 2005: Messiah College, Grantham, PA
Theme: Energy, Conservation and the Environment
Program Chair: Kenell Touryan
Local Arrangements Co-chairs: Ted Davis and Jerry Hess

July 28–31, 2006: Calvin College, Grand Rapids, MI
Local Arrangements Chair: Hessel Bouma III

Does the Bible Teach a Spherical Earth?

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A number of young-earth creationists purport to find in Isa. 40:22 and Job 26:7 evidence that the Bible teaches that the earth is spherical. A detailed analysis of key Hebrew words and their translations in ancient and modern versions shows that there is no substantive evidence and thus no warrant for this claim. This analysis is framed in the context of teaching a course in religion and science, and addresses the fundamental question, also explored in the course, of how one should interpret the Bible in the light of scientific knowledge.

Four years ago, I began to teach a seminar for college seniors entitled "Science and Faith,"[1] one of several core courses offered at Berea College under the rubric Seminar in Christianity and Contemporary Culture. This course looks at major elements of the contemporary scientific world picture and its engagement by various Christian thinkers and writers in the fields of theology and spirituality. Through student presentations on Scientific Creationism, I learned that a number of young-earth creationists purport to find in the Bible evidence of facts about the earth and the universe that modern science has either confirmed in the past or only discovered in recent times. One of their claims, that the Bible teaches that the earth is spherical, has been spread abroad in lectures, publications, and web site articles. Two years ago, Gary Parker of the Answers in Genesis organization made this claim in a Creationism Seminar held in Berea, Kentucky, and jointly sponsored by a Berea College student Christian organization and four local churches. Mark Eastman also made this claim in his article, "Science and the Bible," posted on the Mars Hill web site, which a student gave me a copy of not long afterwards.[2] As I inquired further, I came to conclude that this notion had become fixed in the writings of many Christians committed to this particular view of the relationship between the Bible and modern scientific knowledge.

I should like to examine this claim and two passages from Scripture on which it is based, using a sample of creationist literature. First, Eastman's article states:

> Despite contrary assertions, the fact of a spherical earth was clearly proclaimed in the Bible by the prophet Isaiah nearly twenty-eight centuries ago ... "It is He who sits above the circle of the earth, and its inhabitants are like grasshoppers [etc.]" Isaiah 40:22 (NKJ). When Isaiah wrote this verse he used the Hebrew word "khug" to describe the shape of the earth. Although this word is commonly translated into the English word "circle," the literal meaning of this word is "a sphere."[3]

The Bible, Eastman writes, offers

> an astonishing piece of scientific foreknowledge ... While speaking of the incredible power of God, Job states of the earth [26:7]: "He stretches out the north over empty space; He hangs the earth on nothing" (NKJ). When we consider that twenty-eight centuries ago the prevailing view of the earth was that it was flat and resting on the back of an animal or Greek god, the biblical view of a spherical earth suspended on nothing is astonishing.

Eastman goes on to assert that the Bible exhibits knowledge about the earth and the universe "that appears to have come from a being with an extraterrestrial perspective."[4]

A year later, one of my students who gave the presentation with another student on Scientific Creationism afterward offered all twenty-one of us

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in the class copies of *Refuting Evolution* by Jonathan Sarfati.[5] (He told me later that Answers in Genesis had provided him with the copies.) Sarfati likewise addresses the "flat earth charge":

> Isaiah 40:22 refers to "the circle of the earth," or in the Italian translation, *globo*. The Hebrew is *Khug* = sphericity or roundness. Even if the translation "circle" is adhered to, think about Neil Armstrong in space – to him the spherical earth would have appeared circular regardless of which direction he viewed it from.

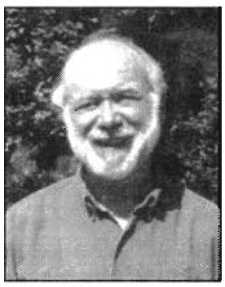
Sarfati goes on to claim that Luke 17:34–36 implies that Jesus knew the earth was spherical, and cites research establishing that "nearly all Christian scholars [since the fifth century AD] who have ever discussed the earth's shape have assented to its roundness."[6]

This claim is also made by one of the most authoritative voices in the young earth creationist movement, Henry M. Morris, whose works my students often cite when writing on Creationism. In *Biblical Creationism: What Each Book of the Bible Teaches about Creation and the Flood*, Morris asserts that *khug* in Isa. 40:22 means "sphericity, ... thus both earth and the deep are components of the great terrestrial sphere ...,"[7] and in *The Remarkable Record of Job*, he claims that Job 26:7 teaches that the earth is a sphere held by the force of gravity in space, and adds, with reference to Job 26:10, "The word *compassed* (Hebrew *khug*) means to be made spherical, referring to the shape of the earth, especially to its sea level, the basic datum for earth's geometry."[8]

These arguments share certain common themes. While the writers assert that the Hebrew *khug* – I shall use *chûgh* – of Isa. 40:22a means "sphericity," they provide no lexicological support. They also assume that Job 26:7 refers to "empty space," that is, the modern concept of physical, astronomical space. Some proponents are primarily concerned with refuting the "canard" (Sarfati) that the Bible teaches a flat earth. They inform their readers that the notion of a spherical earth was common among early and medieval Christian thinkers.[9] Yet they do not make the case that these thinkers took the notion of a spherical earth from the Bible. In supporting their interpretations, they also appeal to the extra-terrestrial perspectives of an astronaut (Sarfati) or God (Eastman).

While I find these arguments either unsubstantiated or irrelevant (e.g., it is what Isaiah saw, not Armstrong, that counts), as a teacher, I take them seriously. My conservative and fundamentalist students bring to the seminar and to our examination of Scripture's many creation hymns and theological proclamations a deep faith in the Bible and (for many) its veracity in all areas of knowledge. Some students consult the web sites of the Institute for Creation Research, Answers in Genesis, the Creation Research Society, and others, where they find a plethora of notes and articles presenting creationist positions and arguments. And they use this material in their class presentations and term papers. Some of these sites offer on-line bookstores where the publications cited here and many others may be purchased. Answers in Genesis, located one hundred miles north of Berea in Florence, Kentucky, has cultivated a relationship with a local campus Christian group. Thus, I have been acquainting myself with creationist materials so that I might be able to engage my students in thoughtful discussions on such topics as the present one when they bring them into the learning experience.

The claim we are considering here raises a fundamental question which my students and I also consider in the course: Just how should one interpret the Bible in light of modern scientific knowledge? This question is addressed directly by Paul Nelson and John Mark Reynolds in their chapter on "Young Earth Creationism" in *Three Views on Creation and Evolution*.[10] The authors critique the position that Galileo Galilei asserted in his 1615 tract on the use of biblical quotations in matters of science.[11] Galileo



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set out as a principle that where a biblical text appears to be contradicted by "truth [about nature] obtained by reason and experiment" it must hold another meaning than its bare words offer, and thus must be reinterpreted to preserve the principle that "all truth agrees with truth." The authors give as an example how Isa. 40:22 and Job 26:7 might be interpreted to express the notion of a spherical earth according to Galileo's approach. Yet they criticize this methodology on the grounds that "it makes Scripture potentially nonfalsifiable" and "frequently fails to take into account a distinction between *observations* and the *conclusions based on observations*."[12]

I will offer a perspective on this critical question later, but first I want to address the claims made for the Isaiah and Job passages by examining the original Hebrew and their translations in both ancient and modern versions. Let us see if this interpretation exemplifies Nelson's and Reynold's concern that in such circumstances as these, "the Bible could theoretically be made to say the opposite of its 'plain sense' and still be defended as 'scientifically accurate,'" for them a "disconcerting" prospect.[13]

Isaiah 40:22a—When is a Circle a Sphere?

Here is how Isa. 40:22 is rendered in the NRSV:

> It is he who sits above the circle of the earth,
> and its inhabitants are like grasshoppers:
> who stretches out the heavens like a curtain,
> and spreads them like a tent to live in ...

The critical line in Hebrew reads (transliterated and omitting vowels): *hyshb 'l hwg h'rtz*, which my colleague Dr. Robert Suder translates: "the one dwelling on the circle/horizon of the land."[14] A survey of Hebrew lexica and theological wordbooks[15] yields much information about the key word *hwg* (*chûgh*).[16] According to K. Seybold, its root appears six times in biblical Hebrew, and it is clear from its usage in context that it has a specifically geometrical meaning, that is, "a circle, as drawn with compasses." In Job 26:10 and Prov. 8:27, *chûgh* is used with *chōq*, meaning "to inscribe a circle."[17] This nominal infinitive form also appears in Job 22:14, where it denotes "the circle of the heavens" (*shāmayim*), and in Isa. 40:22a, where it denotes "the circle of the earth" (*hā'ārets*). Sir. 43:12[18] uses *chûgh* in describing the rainbow. Finally, in Isa. 44:13, *mᵉchûghāh*, a hapax legomena (a form used only once), means "a compass," i.e., that simple instrument people my age used to draw circles in high school geometry class.[19]

All but one of these contexts are cosmological, and in fact four of the five uses of *chûgh* occur in creation hymns. Isa. 40:22a describes God as sitting/dwelling above "the circle of the earth" which God laid out—with a compass, as Job 26:10 and Prov. 8:27 suggest, for the latter verses describe the act of inscribing the circle that fixes the boundary between the earth and the deep, the circle that also marks the boundary between light and darkness.[20] The context also suggests that in Isa. 40:22a, the earth (*'erets*) which is encircled refers not to the earth as that part of the creation distinct from the heavens (Gen. 1:1)—as the creationists cited above seem to interpret it—but to other meanings of earth: as "the dry land" (Gen. 1:9–10), and at the same time, it appears, as "the ground on which people and things stand," for "its inhabitants are like grasshoppers."[21]

A circle is no more a sphere in Scripture than it is in geometry.

Looking at these usages together, I am hard put to see how anyone could justify rendering *chûgh* in Isa. 40:22a as "sphericity."[22] The earliest translations of these Scriptures bear this out. In the Septuagint (LXX), the translators render the nominal and verbal forms of *chûgh* in every case with the Greek *gýros* (noun), "circle" or "ring," which they use in Isa. 40:22a, or *gyróo* (verb), "to make or inscribe a circle."[23] *Gýros* does not mean "sphere,"[24] and in fact nowhere in any Greek recension of the Hebrew Scriptures will one find the proper word *sphaîra* used in this context at all.[25] The history of the formation of the LXX is largely lost, and we do not know if the Prophets were translated in Alexandria as the Torah was in the third century BC.[26] But if they were and if the translators were familiar with the concept of a spherical earth taught at the Museon of Alexandria, then the center of Greek science, they give no hint of it in their translation of *chûgh*.

Greek *gýros* turns up in its transliterated form *gyrus*—present in Roman literature as early as Lucretius (mid-first century BC)—in the Latin versions of the Bible as well.[27] St. Jerome (c. 340–420), the early Latin Church's master linguist and Bible translator, began his work on the Old Testament by creating a standard version from the several unreliable Old Latin recensions then in existence, using as a valuable aid Origen's fair copy of the *Hexapla* which he consulted in the library at Caesarea around 386 AD.[28] The Old Latin recensions were based on the LXX and commonly rendered this

same portion of Isa. 40:22a as "*qui tenet gyrum terrae.*"[29] Later, when he prepared a new version from the Hebrew that would become part of the Vulgate, he kept the Old Latin reading, changing only the verb *tenet*, "dwells," to *sedet*, "sits."[30] And in his *Commentary on Isaiah*, Jerome, who is regarded by critics today as a competent and careful scholar,[31] specifically rejected the notion that in this verse the prophet is referring to a spherical earth.[32]

When we come to English versions, both early and recent, we find *chûgh* interpreted in two different ways. The translators of the Authorized Version of 1611 were guided by the Geneva Bible, the version produced by English exiles in 1560, and adopted the latter's reading verbatim: "... sitteth upon the circle of the earth ..."[33] Many late twentieth-century versions follow them (NKJV, NJB, NIV, NRSV), but some others render *chûgh* as "vault" (JPSV, NAB), "vaulted roof" (REB) or "dome" (J. McKenzie[34]), interpreting the word to refer to the "vaulted dome of the heaven" (suggesting the *rāqî'a* of Gen. 1:6–7), upon which God "sits" or "dwells" or "sits enthroned."[35] Seybold, however, rejects this interpretation and points to Isa. 40:22b in support of "circle." The image of God sitting above the vaulted dome rather than the horizon circle would not change the divine perspective in any significant way, but I agree with Seybold that these renderings depart from the contextual meaning of *chûgh*.[36]

The prophet who uttered the words of 40:22 is the same prophet who proclaimed that Yahweh is the Creator who "spread out the earth" (42:5; 44:24). The Hebrew verb in both passages is *rāqa'*, which means "to stretch out, spread out or abroad, cover over" and, according to Theodore Gaster, "to flatten out."[37] Among his people in the exile community in Babylon,[38] looking out over the enormous desert expanse that reached from horizon to horizon, it is not surprising that this prophet would describe God as "flattening out" the land. These other expressions also militate against the notion that the prophet was implying a spherical earth in 40:22a, and they act as a check against focusing upon one verse and reading it outside the larger context of this prophet's other inspired oracles of creation and salvation.

If creationists had sought any support among biblical philologists, they might have found a nod given to them in the article on *chûgh* by Edwin Yamauchi in the *Theological Wordbook of the Old Testament*. "Some have held," he states, "that Isa 40:22 implies the sphericity of the earth. It may, but it may refer only to the Lord enthroned above the earth with its obviously circular horizon."[39] Yamauchi offers no supporting evidence for this concession to opinion, and in fact there is none that he or anyone else could give: a circle is no more a sphere in Scripture than it is in geometry. The preponderance of philological evidence and the translations of ancient scholars and modern experts alike provide overwhelming testimony that Isa 40:22a does not refer to a spherical earth. There is simply no warrant for Eastman, Sarfati, and Morris to declare, contrary to its plain sense and in violation of its semantic domain, that *chûgh* literally means sphericity. They have read the earth's sphericity into the text, not out of it. And this is the conclusion to which I would lead my students.

Job 26:7—Empty Space or Whatnot?

Yamauchi concludes his article with: "Note the remarkable concept given in Job 26:7." Let us turn

Abbreviations

HELOT:	W. Genesius and E. Robinson, *A Hebrew and English Lexicon of the Old Testament*, ed. F. Brown, et al. (Reprint, Oxford: Clarendon Press, 1968).
IDB:	C. A. Buttrick, et al., eds., *The Interpreters Dictionary of the Bible*, 4 vols. (Nashville: Abingdon Press, 1962).
JPSV:	The Tanakh: Jewish Publication Society Version (1988).
KJV:	Authorized or King James Version (1611).
NAB:	New American Bible (1990).
NIDOTTE:	W. A. Van Gemeren, gen. ed., *New International Dictionary of Old Testament Theology and Exegesis*, 5 vols. (Grand Rapids: Zondervan, 1997).
NIV:	New International Version (1978).
NJB:	New Jerusalem Bible (1985).
NKJV:	New King James Version (1982).
NRSV:	New Revised Standard Version (1989).
REB:	Revised English Bible (1989).
TDOT:	G. J. Botterweck and H. Binggren, *Theological Dictionary of the Old Testament*, trans. D. E. Green. 10 vols. (Grand Rapids: Eerdmans, 1999).
TLOT:	Ernst Jenni and Claus Westermann, eds., *Theological Lexicon of the Old Testament*, trans. M. E. Biddle. 3 vols. (Peabody, MA: Hendrickson, 1997).
TWOT:	R. L. Harris, G. L. Archer, and B. K. Waltke, eds. *Theological Wordbook of the Old Testament*, 2 vols. (Chicago: Moody Press, 1980).

now to this other passage. Here is how the NRSV renders this verse:

> He stretches out Zaphon over the void,
> and hangs the earth upon nothing.

Like the poetic oracles of the prophet who proclaimed the words of Isa 40:22, the Book of Job contains some of the most powerful and affecting verse in the Old Testament. And Job 26:7, a couplet with a subject-verb-object-preposition-object arrangement, exemplifies an important feature of Hebrew poetry, its parallel structure. Here is the verse in a consonantal transliteration, followed by Suder's literal translation:

> *nth tzphn 'l - thw*
> *tlh 'rtz 'l - bly-mh*
>
> [He] stretches Zaphon upon chaos,
> suspends the land upon what (not)?

Perhaps picking up on Yamauchi's reference, Walter Kaiser writes in his article on *bᵉlîîmâ*: (from *bᵉlîî* and *mâ*: "not-aught"): "Found only in Job 26:7. The Lord 'hangs the earth upon nothing' (RSV), a remarkable vision of the earth being supported in space by the power of God."[40] It is this notion of the earth hanging in space that perhaps has encouraged creationists like Eastman and Morris to claim that this verse also refers to a spherical earth, although there is nothing that indicates plainly what shape of the earth the poet had in mind. I shall contend that interpreting Job 26:7 is a far from simple matter, and that its meaning is shrouded in mystery. The question is, can the mystery be penetrated?

The ambiguity that characterizes this poetic hymn verse begins in the first line with "Zaphon," which some translators retain in English (NRSV, JPSV, Marvin Pope[41]) while most render it as "the north" (Geneva Bible followed by KJV and NKJV; NAB, NJB); the REB reads "the canopy of the skies" and the NIV reads "the northern skies."[42] The Hebrew *sāpôn* is of uncertain etymology, but in the Canaanite tablets unearthed at Ugarit in 1927, Zaphon is described as the mountain of the *ba'alim*. It has been identified with Mt. Casius in northern Syria. Zaphon as mountain is found in other passages of the Old Testament: in the derision song of Isa. 14:4–20, Zaphon is identified with the mount of assembly of the gods in the north (v. 13); and in the praise psalm 48, Zion the mount of Yahweh is called (v. 2) "peak of Zaphon."[43] *Sāpôn* also came to mean "the north" as a compass point or geographical location.[44] It was probably with this interpretation in mind that the LXX used the Greek word for "north," *boréan;* and both the Old Latin and the Vulgate used *aquilonem,* the Latin equivalent. Likewise, many English versions have used "the north." Since heaven and earth are often coupled in creation hymns, some translators have interpreted *sāpôn* here to mean "the heaven."[45] W. H. Schmidt opines that it is difficult to imagine a mountain being "stretched out,"[46] and there are those passages in Isaiah in which God is said to "stretch out" the heavens (40:22b; 42:5; 44:24). Still, there is little consensus among translators as to its meaning.

In the next line, there is a remarkable image: God "hangs (or, suspends) the earth upon nothing." What does "hang" mean in this context, and what meaning of "the earth" is to be understood? The Hebrew word *tâlâh* here means "hang" in the sense of "hang something on something," e.g., upon a peg (cf. Isa. 44:23–24; Ezek. 15:3).[47] The meaning of "earth" (*'erets*) here seems somewhat ambiguous: it may refer to the earth as the other part of a bipartite creation,[48] but it may refer also to the earth as "the land." The combined words may remind one of Job 38:12–13, where God commands the dawn to "take hold of the skirts of the earth" (NRSV) and shake the wicked out of it.[49] Does the poet by this metaphor suggest that the earth is to be imaged as a garment, not hanging down, perhaps, but spread out? No certain answer can be given, I think.

The crux of this remarkable couplet, however, lies in the words that end each line. In the first, God "stretches Zaphon over *tōhû*," and in the second he "hangs the earth upon *bᵉlîîmâ*." In the parallelism that characterizes Hebrew poetry, the same thing or concept is often repeated using a different word or phrase, so it may be that *bᵉlîîmâ* in some way repeats or develops the notion intended by *tōhû*. I shall review the various meanings of these terms, then examine how they have been rendered.

The first, *tōhû*, harks back to the *tōhûwabōhû* of Gen. 1:1, where the earth, i.e., the other part of the creation besides the heavens, is described as "formless and empty." HELOT refers specifically to Job 26:7 in giving "nothingness, empty space" as meanings. A. H. Konkel, citing the same verse, reads *tōhû* as "nothingness, void, emptiness."[50] The word that concludes the second line is a hapax legomena composed of *bᵉlîî* and *mâ*.[51] *Mâ* functions both as an interrogative and as an indefinite pronoun, meaning "What?" "How?" or "aught."[52] *Bᵉlîî*, meaning "not," is a negative used primarily in poetry; rather than negating something it conveys the sense of "without something."[53] Kaiser renders *bᵉlîîma* as "not aught."[54] But might *mâ* have an interrogative rather than an indefinite force here, as in Suder's translation? Is the poet asking "what?"

If we put these two together, do we have a notion resembling *tōhûwabōhû*, something that is akin to "formless and empty"? Does *bᵉlîîmâ* reinforce and make stronger the meaning of *tōhû*, the author expressing more intensely the sense of nothingness and emptiness over and upon which God "stretches" and "hangs"? Such an interpretation, and the parallelism evident in this couplet, might, in turn, lead the reader to take "Zaphon" literally, referring not to the northern skies but to the mountain that rests upon the earth to the geographical north and which might be understood as an earthly dwelling place of God, so that the whole couplet refers to the earthly part of the creation hung and stretched out over the mysterious "not-anything."

In 1560 and 1611, the heavens were understood to consist of a series of concentric spheres filled with the element aether; there was no such concept as "empty space," at least not one acceptable to the great majority of the educated.

Kaiser remarks that while it would be improper to impose twentieth-century cosmological knowledge on this creation hymn, "it is nonetheless striking that 26:7 pictures the then-known world as suspended in space. In so doing, it anticipates (at the very least!) future scientific discovery."[55] Comments like this as well as renderings of *tōhû* as "empty space" might give encouragement to creationist interpreters of this verse. Before assessing this translation, let us see what tradition offers.

The LXX translators appear to have understood these two words to be equivalent, for they rendered both by the Greek neuter form *oὐdén*, "nothing," using in the first line the accusative singular *oὐdén*, in the second the genitive singular *oὐdenós*, both with the same preposition, *ἐpí*, "upon" or "over," which may express the concept of place with either grammatical case, and in particular with the accusative can convey the meaning of "extension over a place."[56] In the Old Latin versions, we find *tōhû* rendered as *nihilum*, *bᵉlîîmâ* as *nihilum in aerem*.[57] In the Vulgate, Jerome, relying on the Hebrew, renders the first with the neuter accusative *vacuum*, the second with the neuter accusative *nihilum*.[58] Both words are introduced by the same preposition, *super*, "above, over, upon." The basic meaning of *vacuum* is "not containing or holding anything, empty." Jerome evidently thought that it conveyed the meaning of *tōhû* better than the *nihilum* of the Old Latin. The latter word has the basic meaning of "not anything, nothing," thus to Jerome conveying the sense of *bᵉlîîmâ*.[59]

The ancient translators seem to have attempted to render the Hebrew as literally as they could. Twentieth-century translators offer a variety of readings. *Bᵉlîîmâ* is rendered as "nothing" (NIV, NKJV, NRSV, Pope), "nothingness" (NJB), "nothing at all" (NAB), "the void" (REB), or "emptiness" (JPSV), all introduced by the prepositions "over" or "upon." *Tōhû* is variously translated as "the void" (NJB, NRSV, Pope), "chaos" (JPSV, REB), or "empty space" (NIV, NKJV, NAB).

I think the translation "empty space" is rather problematical. It is instructive to examine the difference between the readings of the KJV translators and their modern revisers. Instead of "empty space" (NKJV) the former, following verbatim the Geneva Bible, translated *tōhû* as "the empty place." Here is the entire couplet:

> He stretcheth out the North (KJV, north) over the empty place,
> and hangeth the earth upon nothing.

The difference is telling to anyone familiar with the world-picture that prevailed in the sixteenth and early seventeenth centuries. The Reformation translators still lived in an Aristotelian and Ptolemaic cosmos, whether or not any of them had become Copernicans. Aristotelian science dominated the universities. In 1560 and 1611, the heavens were understood to consist of a series of concentric spheres filled with the element *aether;* there was no such concept as "empty space," at least not one acceptable to the great majority of the educated. While it had come under serious criticism by some Renaissance philosophers, Aristotle's concept of Place (*tópos*) still held sway. For Aristotle, everything in the Cosmos exists in a Place, which he defined as the "containing vessel" of a thing. The inner sphere of the revolving heavens constitutes the containing vessel of the earth, and likewise, within the domain of the earth each thing's place "must need be ... the limiting surface of the body continent—the content being a material substance susceptible of movement by transference." In his exposition of this difficult concept in the *Physics*, Aristotle goes on to argue specifically against the existence of the Void, a central component of Epicurean atomism.[60]

While the word "space" is attested in English as early as the fourteenth century, it is not used to convey the notion of physical or astronomical space, certainly not the absolute space of Newton or the relative space of Leibniz, before the middle of the seventeenth century.[61] Because of its association with atheism, the concept of the Void also was not popular; atomism needed a "baptism" by theoretical physicist Pierre Gassendi in the 1650s to render it respectable enough to be incorporated into a world view acceptable to Christian thought.[62] The Protestant translators in Switzerland and England would not have understood the concept implied in the "empty space" of their latter-day revisers.

The translation "empty space" invites a popular interpretation based on a modern cosmology, not on the cosmology of the ancient Hebrews, and it lends encouragement to readers, whether creationists or not, to see in this passage in Job an "anticipation" of a modern concept.

Yet, if these translators breathed an atmosphere that was Aristotelian and had the notion of Place as a part of their world view, they have turned it on its head. No place in Aristotle's world is "empty," but these translators have written "the empty place." What did they mean by "place" here? Specifically, what did they mean by "the empty place"? Were they expressing what to them would seem a paradox? Or were they simply trying to make sense of *tōhû* given its basic meaning and this context, perhaps guided by the *ἐp' oὐdén* of the LXX, with the prepositional sense of "extension over a place"? What they could not have meant by it is the "empty space" of a modern scientific world-picture, and that is what makes this particular translation so problematical. I think it is a good example of how a sincere attempt to render an ancient and puzzling expression into a term comprehensible to a contemporary readership can lead to misunderstanding.[63] The translation "empty space" invites a popular interpretation based on a modern cosmology, not on the cosmology of the ancient Hebrews, and it lends encouragement to readers, whether creationists or not, to see in this passage in Job an "anticipation" of a modern concept. But, to go from an indefinite "emptiness" and "what-not" to "empty space" or "infinite space" (NJB comment) is too big a stretch, too expansive an interpretation. Better, I think, to leave its meaning a mystery, as it seems to have been to the translators who gave us "the empty place" of the 1560 and 1611 versions.

What, then, can we make of Job 26:7? While its sense is hardly plain, one notion it certainly does not convey, I would tell my students, is that of a spherical earth held by the force of gravity in space (Morris). The earth that hangs on nothing is also the earth that rests on "pillars," which tremble when God shakes the earth (Job 9:6), or upon a "foundation" with bases and a cornerstone (Job 38:6). It is also the dry land that God separated from the waters of the encircling deep (Gen. 1:9–10; Job 26:10; Prov. 8:27), that the psalmists describe as "founded ... upon the ocean, set ... upon the nether-streams" (24:1–2, JPSV; cf. Exod. 20:4), the earth which God "stretched out ... above the waters" (136:6 KJV). I see no value in trying to reconcile these many and varied metaphorical images with our own image of a spherical, rotating planet—aside from the fact that these ancients did not think of the earth as a planet. What Job 26:7, indeed the entire creation hymn of which it is a part, does convey, in all of its majesty and mystery, is the presence and power of the One who creates and sustains, and who holds all of the creation under his gaze. The response it calls for is awe, not scientific analysis.

Respecting paradigms

I want to return now to the fundamental question posed above: How should one read the Bible in light of modern scientific knowledge? This is an issue with many perspectives, and a comprehensive review belongs to another article. But I would like to share some thoughts that I offer to my students for their consideration. I agree with Nelson and Reynolds that one should not read meanings into biblical texts that are not there in order to make them conform to modern scientific knowledge.[64] Regretfully, some of their colleagues in the young earth creationist movement are prone to do just that.

Besides the earth's sphericity, Eastman purports to find references to such modern scientific knowledge as ocean currents (Isa. 43:16; Ps. 8:8), elementary particles (Heb. 11:3), and nuclear explosions (2 Peter 3:10).[65] Such fanciful eisegesis as this is matched by Morris' readings into the text of Job, whom he credits with knowledge of the hydrological cycle (28:24–27), the rotation of the earth (38:12–14), and an expanding, unbounded universe (22:12; 9:8), among other things.[66] Their writings reveal a sincere

devotion to the Bible and a desire to convince others that the Bible is "scientifically accurate," but I have to say, with respect, that I think such extreme readings into the texts really do a disservice to the Bible. In claiming that Holy Scripture contains accurate scientific knowledge that only our age has caught up with, they empty these passages of their historical, cultural, or cosmological meanings and impose upon them meanings which the texts themselves simply cannot bear. As Augustine put it, so well, they find not what is in Scripture but in themselves as interpreters.[67] Consequently, what the biblical writers themselves sought to convey is lost, and the Christian who reads these and other texts through these creationist lenses is deprived of the pleasure of wrestling with their intended meanings.[68]

The biblical writers offer believers a valuable lesson for interpreting the doctrine of creation: one can take whatever is the current cosmological model and use it to understand more deeply and clearly God's relationship to the creation.

My Christian students are wrestling intellectually and emotionally with another perspective. They read popularizers of science who tell them that the Bible offers a "pre-scientific" view of the world, and question its veracity; they see some of these same persons dismiss the Bible as of no value in the light of the sure and certain knowledge that science provides. Also, in their high school and even some college science courses, they are often given the impression, whether intended or not, that former scientific theories and notions have been replaced simply because they were wrong, and they are not taught to give outmoded theories the respect they deserve. One of my tasks is to help them recognize the fallacies of these perspectives, understand what the scientific enterprise really consists of, and realize that they may value and honor the world view of the ancient Hebrews without thinking either that they must prove that modern scientific concepts are already in the Bible or that they must reject certain paradigms of mainstream science today in order to be true to God and to God's Word.

Before my students examine creation texts in the Bible, we explore the characteristics of scientific theories, models and paradigms, and note their similarities and differences with theological models and paradigms. I hope that they will grasp the notion that all interpretations of scientific data are theory-laden and historically contextual. Then, when we look at Scripture, I try to help them recognize that the same is true of the ancient bipartite and tripartite cosmological models implicit in the texts of Genesis, Isaiah, Job, the Psalms, and other books of the Old Testament and the Apocrypha.[69] Yet, while these cosmologies may be quite different from and superseded by today's, they are no less worthy of understanding and respect. More importantly, I hope that my students will come to see that "creation" in the Bible really belongs to the realm of theology, not science, that how the biblical writers interpreted what we call scientific data is no more timelessly true (nor do I believe that God would expect anyone to think it so) than the interpretations of today's scientific community, that what Scripture reveals first and finally is God's *relationship* to the creation, that it is the *revelation* of creation (both as divine action and as the universe brought into being) that remains timelessly true, however our theological understanding of that revelation may change over time.

The theological truths about creation which Scripture proclaims are not dependent upon the cosmological models in which they are set. In fact, the biblical writers offer believers a valuable lesson for interpreting the doctrine of creation: one can take whatever is the current cosmological model and use it to understand more deeply and clearly God's relationship to the creation. That is what Second Isaiah, the author of Job, and the writer(s) of Genesis 1 did: they conveyed revelations about creation using the "standard model" of the cosmos they shared with their Semitic neighbors, while at the same time challenging and rejecting their theogonies and theologies. And we can do the same.

Creationist Paul Humber, less certain that Isa. 40:22a and Job 26:7 refer to a spherical earth, suggests that his colleagues are perhaps "forcing too much on Scripture." Rather, he wrote: "... our Lord's sovereignty over all was and is the primary focus."[70] This is precisely what I hope my students will come to realize. They do not have to choose between modern science and the Bible. They do not have to find modern scientific knowledge in the Bible in order to keep on believing in it. They can have it both ways.

Concluding Scientific Postscript

As we shared our views on reading the Bible in the light of modern scientific knowledge, Bob Suder asked:

> "What can the ancient Israelites teach us about their world view that we might not see otherwise? What can they tell us that we never would have dreamed of? How can their cosmogony inform our cosmology?"

I looked down at the text of Isa. 40:22b at that moment and said:

> "I've often wondered what the prophet meant by the 'curtain' of the heavens."
>
> "You've been to the Middle East, haven't you?"
>
> "Yes, in June of 1982, I went to Israel and Egypt on the Berea College Alumni Tour."
>
> "Did you see the curtain when you were there?"
>
> "No, did you?"

Bob, who had been a surveyor and excavator at archeological sites in Israel and Jordan for several seasons, answered:

> "Yes, many times, especially on the Madaba Plains and the region of ancient Moab. It was visible at other places but not so pronounced. The last time I flew out of Amman, I saw it again as our plane taxied on the tarmac. I looked out the window and saw that a huge cloud of desert dust had filled the skies and stretched across the horizon. In its 'folds' it looked like a curtain or a tent from the inside. It is one of the memories of the Near East that seems to summarize the whole experience."

Bob reminds us all of an important fact about the cosmology of our spiritual ancestors. We shall appreciate their world view best when we are able to put ourselves in their place. The prophet and the poet, and all this company that the Holy Spirit inspired—we shall do them justice when we learn to see the universe through their eyes instead of our own. And, we shall do them justice whenever we remind ourselves that theirs are eyes not only of sight but also of faith.[71] ✻

Notes

[1]Described in my article, "Science and Faith," *Religion and Education*, 26.2 (1999): 31–42.

[2]<www.marshill.org/Apologetics%20Pages/science_and_the_Bible.htm>.

[3]Ibid.

[4]Ibid.

[5]Jonathan Sarfati, *Refuting Evolution* (Green Forest, AR: Master Books, 1999).

[6]Ibid., 97–8. We shall see below why Sarfati had to go to an unnamed Italian translation for a word meaning "globe."

[7]Henry M. Morris, *Biblical Creationism: What Each Book of the Bible Teaches about Creation and the Flood* (Green Forest, AR: Master Books, 2000), 113.

[8]____, *The Remarkable Record of Job* (Green Forest, AR: Master Books, 2000), 40, 42. I do not understand what Morris means when he says that the sea level is "the basic datum for earth's geometry."

[9]Similar arguments are presented by Danny L. Faulkner, "Creation and the Flat Earth," posted on the Creation Research Society web site: <www.creationresearch.org/creation_matters/> and by Donald B. DeYoung, *Astronomy and the Bible*, 16–7, excerpted and posted on the Answers in Genesis web site: <www.answersingenesis.org/docs/400.asp>. DeYoung also claims that Job 26:7 implies a spherical earth.

[10]J. P. Moreland and John Mark Reynolds, eds. *Three Views on Creation and Evolution* (Grand Rapids, MI: Zondervan, 1999).

[11]Galileo Galilei, "Letter to the Grand Duchess Christina Concerning the Use of Biblical Quotations in Matters of Science," in *Discoveries and Opinions of Galileo*, trans. Stillman Drake (New York: Doubleday Anchor, 1957), 175–216. My students read this treatise and examine Galileo's argument and its implications after they have completed several classes in which they have compared theories, models, paradigms, and research programs in science and theology, and then have read and discussed the meanings of biblical passages pertaining to creation.

[12]Ibid., 67–8. I assume Nelson and Reynolds mean "nonfalsifiable" relative to human knowledge preserved in the Bible about nature. Certainly all revelation, doctrinally speaking, about creation and salvation is nonfalsifiable.

[13]Ibid., 70.

[14]Suder is professor of Hebrew and Old Testament at Berea College. I am grateful for his most helpful assistance and instruction.

[15]For Hebrew words, I have consulted HELOT, NIDOTTE, TDOT, TLOT, TWOT, and James Strong, *The Exhaustive Concordance of the Bible* (1894; reprint: Peabody, MA: Hendrickson, 1990).

[16]HELOT, 295, s.v. I shall adopt transliterations of Hebrew, including vowels, used in the lexica cited above.

[17]"He has inscribed a circle on the face of the waters, at the boundary between light and darkness" Job 26:10; "When he established the heavens, I was there, when he drew a circle on the face of the deep" Prov. 8:27 (NRSV).

[18]While Sirach is not part of the Hebrew canon, it is one of the deuterocanonical books which survives in Hebrew.

[19]K. Seybold, TDOT, 4:244–7.

[20]Ibid., 247.

[21]H. H. Schmid, TLOT, 1:172–7, provides a detailed analysis with references of the various uses of *'erets*; see esp. 174–5 (3b-c). Likewise, M. Ottosson in extenso, TDOT, 1:388–401.

[22]Neither HELOT, NIDOTTE nor TDOT give "sphericity" as a translation of *chûgh*.

[23]Alfred Rahlfs, ed., *Septuaginta, id est Vetus Testamentum graece iuxta LXX interpretes*, 2 vols. in 1 (1959; reprint, Stuttgart: Deutsche Bibelgesellschaft, 1979), s.v. Greek words have been transliterated.

[24]H. G. Liddell and R. Scott, ed., *A Greek-English Lexicon*, (hereafter GEL), new ed. by H. S. Jones and R. McKenzie (1940; reprint, Oxford: Clarendon Press, 1966): s.v. *gýros*, "circle, ring," where the LXX readings of Job 22:14 and Isa. 40:22 are cited; also *gyróo*, "to make round," where Sir. 43:12 is cited.

[25]The word never appears in the modern critical edition of the LXX and only once in the two early second century AD versions of Aquila and Theodotion: in Isa. 29:3, a passage on a quite unrelated topic (E. Hatch and H. A. Redpath, comp., *A Concordance to the Septuagint and the other Greek Versions of the Old Testament*, 3 vols. in 2 [1954; reprint, Peabody, MA: Hendrickson, 1990], vol. 2, s.v.).

[26]J. W. Wevers, "Septuagint," IDB, 4:273–4.

[27]A. Souter et al., *Oxford Latin Dictionary* (hereafter OLD) (Oxford: Clarendon Press, 1974–1982), s.v. "gyrus" (3). Lucretius, coincidentally, uses *gyrus* to mean the arc of the incomplete circle of a rainbow (*De rerum natura*, 4.79), just as Sirach uses *chûgh* (43:12).

[28]E. F. Sutcliff, "Jerome," in *The Cambridge History of the Bible*, vol. II, *The West from the Fathers to the Reformation*, ed. G. W. H. Lampe (Cambridge: University Press, 1969), 86, 88–9. In the *Hexapla*, Origen arranged in six parallel columns the Hebrew text of the Old Testament, the Hebrew transliterated into Greek letters, and the recensions of Aquila, Symmachus, the revised LXX, and Theodotion respectively: Wevers, 275. See the detailed study of Jerome's relationship to the *Hexapla* by A. Kamesar, *Jerome, Greek Scholarship, and the Hebrew Bible* (Oxford: Clarendon Press, 1993).

[29]Isa. 40:22a: D. Peter Sabatier, ed., *Bibliorum sacrorum latinae versiones antiquae, seu Vetus italica* (Rheims: Reginaldus Florentain, 1743), 581a. I am grateful to Dr. Louis Jordan, Director of Special Collections, Hesburgh Library, University of Notre Dame, for providing materials on the Old Latin and Jerome.

[30]Isa. 40:22a: Bonifatius Fischer, et al., eds., *Biblia Sacra iuxta vulgatam versionem* (Stuttgart: Deutsche Bibelgesellschaft, 1969).

[31]H. F. D. Sparks said: "Jerome was, next to Origen, the greatest biblical scholar of the early Church," in "Jerome as a Biblical Scholar," in *Cambridge History of the Bible*, vol. I, *From the Beginnings to Jerome*, ed. P. R. Ackroyd and C. F. Evans (Cambridge: University Press, 1970), 510; see also the assessment by Bruce M. Metzger, *The Early Versions of the New Testament. Their Origin, Transmission and Limitations* (Oxford: Clarendon Press, 1977), 330–3.

[32]*S. Hieronymi Presbyteri Commentariorum In Esaiam Libri*, XI, ed. M. Adriaen. Corpus Christianorum, 73 (Turnholt, Belgium: Brepols, 1963), 2:463. Jerome's comment shows that interpreting the Bible in light of current scientific theory or knowledge has a long history in Christianity. Having in mind the popular Aristotelian theory of the four elements, which makes earth the heaviest and water the lighter element, he states that God "[had] established the great mass of the land and had gathered it together above the seas and rivers, so that the heaviest element [earth] hangs over the lighter weight waters by the will of God, who like a king sits above the circle of the earth." (*Deus, qui tantam molem terrae fundas[set] et super maria et super flumina collocasset eam, ut elementum grauissimum super tenues aquas Dei penderet arbitrio, qui instar regis sedet super gyrum terrae.*) Although, he adds: "there are some who assert that this mass is like a point and globe" [scil., in the center of the universe, according to Greek theory] ... (*Ex quo nonnulli quasi punctum et globum eam [molem terrae] esse contendunt ...*), Jerome rejects this assertion: "What, then, will the land be over ...?" (*Quid igitur superbit terra ...?*) (ibid., xl, 21/26). Those "some" Jerome had in mind may have been Christian contemporaries, but he also may have been reminded of the views expressed in the works of one of his favorite pagan authors, Cicero, who uses *punctum* and *globum* to characterize the earth in *Republic*, 6.16, and *Tusculan Disputations*, 1.68, respectively, though it is not clear that in the latter Cicero is referring to a spherical earth, as some have contended: see the note loc. cit. by J. E. King, ed. and trans., Cicero, *Tusculan Disputations*. Loeb Classical Library (London: Heinemann, 1966), 80.

[33]*The Geneva Bible. A Facsimile of the 1560 Edition*, introd. L. E. Berry (Madison: University of Wisconsin Press, 1969). The Geneva Bible, so popular in England that it continued to be printed down to 1644, exerted a great influence upon the team that produced the KJV, particularly in the prophetic books: ibid., 17.

[34]*Second Isaiah*, introd., trans., and notes by John L. McKenzie. The Anchor Bible, 20 (Garden City, New York: Doubleday, 1968), 21–2.

[35]L. C. Allen, NIDOTTE, #2553, 2:40-41, supports this interpretation: *chûgh* "refers to the dome that dammed the upper ocean to prevent it breaking through to the earth."

[36]Ibid., 246. Suder noted that *rāqî'a* is derived from the verb *rāq'*, defined below. The most common image this verb conveys is of hammering a piece of metal to transform it from a lump to a sheet. *Rāqî'a*, then, would have the connotation of "expanse" rather than "dome" or "vault."

[37]J. Barton Payne, TWOT, #2217, 2:861–2; Gaster, "Earth," IDB, 2:2–3.

[38]I agree with those biblical scholars who have concluded that chapters 40–55 of the Book of Isaiah are the work of a different prophet from Isaiah of Jerusalem.

[39]TWOT, #615, 1:266–7.

[40]TWOT, #246, 1:248.

[41]*Job*, introd., trans. and notes by Marvin H. Pope. The Anchor Bible, 15 (Garden City, NY: Doubleday, 1965), 163.

[42]The NJB comments that "the North" here means "the northern quarter of the firmament, on which the firmament was thought to revolve." Compare the marginal note in the Geneva Bible: "He causeth the whole heaven to turn about the North pole."

[43]This is but one of many images from Canaanite myth and cult which were taken over and transformed by the Israelites in their struggle with Ba'alism; it is Yahweh who rides the storm clouds, not Ba'al (cf. Ps. 18:10–14).

[44]Pope, ibid., 165. I have relied particularly on the essay on *sāpôn* by W. H. Schmidt, TLOT, 3:1093–8. NRSV textual note: "Zaphon, or the North."

[45]JPSV textual note on Zaphon: "used for heaven"; NAB comment: "The North: used here as a synonym for the firmament, the heavens ..."; see also note 42, above.

[46]TLOT, 3:1096. Schmidt may have had Alpine peaks in mind, but anyone who has sighted the length of Pine Mountain in Kentucky or Clinch Mountain in Tennessee would have no difficulty describing those mountains as being "stretched out." The same could be said of the massif of the Moab range when viewed from the western side of the Dead Sea.

[47]HELOT, 1068 s.v., citing also this verse; R. S. Hess, NIDOTTE, #9434 (5), 4:296.

[48]Ottosson, TDOT, 1:394 cites Job 26:7 as an example of this meaning.

[49]Stoltz, TLOT, 1:174. Stoltz refers to an Akkadian "Hymn to Shamash" in which the sun god is said to be "holding the ends of the earth suspended from the midst of heaven."

[50]HELOT, 1062, s.v.; Konkel, NIDOTTE, 1:607, #983. Ronald Youngblood states that since *tōhû* "has no certain cognates in other languages, its meaning must be determined solely from its Old Testament contexts" (TWOT, #2494, 2:964).

[51]Kaiser, ibid., 248.

[52]HELOT, 552, s.v.

[53]Suder, in conversation, September 11, 2000.

[54]Ibid.

[55]Ibid., 965. An NJB comment is more explicit: "The only verse in the Bible that hints at infinite space."

[56]LXX, ed. cit., loc. cit.: *ἐp'odýén; ἐpíodýenós*; cf. GEL, s.v. *ἐpí*.

[57]Sabatier, ed. cit., loc. cit., 1:876a. In using *nihilum* twice, the translators may have been influenced by the LXX, but the addition of *in aerem* ("into the air") to the second *nihilum* introduces an unusual and puzzling interpretation.

[58]*Biblia sacra iuxta vulgatam*, loc. cit.

[59]On the meanings see OLD, s.vv. "vacuus" (1); "nihilum" (1). Regretfully, Jerome did not write a commentary on Job, so we do not have the benefit of any ruminations he might have had on these words, which would likely have been based on discussions with the rabbi in Lydda who tutored him on Job.

[60]Aristotle, *Physica*, IV, i–v, 208a–213a. *The Physics*, trans. Philip H. Wicksteed and Francis M. Cornford, Loeb Classical Library (1929; reprint, London: Heinemann, 1962), 1:274–327, esp. 213a, p. 313. Aristotle refutes the concept of the Void in IV, vi–ix, 213a–217b, 328–71.

[61]*Oxford English Dictionary*, 2d ed., comp. J. A. Simpson and E. S. C. Weiner (Oxford: Clarendon Press, 1989), 16:88, esp. (8). Interestingly, the earliest attested usage of "space" meaning astronomical space recorded in the OED is by John Milton (*Paradise Lost* [1667], I, line 650).

[62]Max Jammer, *Concepts of Space. The History of Theories of Space in Physics*, 2d ed. (Cambridge: Harvard Univ. Press, 1969), provides a detailed and informative survey. See esp. chaps. 3 and 4. Gassendi's theory of a homogeneous and infinite space, shaped in part by the ideas of Renaissance thinker Tommaso Campanella, was incorporated by Newton into his grand synthesis (ibid., 92–4). See also A. Koyré, *From the Closed World to the Infinite Universe* (1957; reprint, Baltimore: Johns Hopkins, 1968).

[63]In *Genesis* (New York: Norton & Co., 1996), xi–xii, Hebraicist and Bible translator Robert Alter gives a trenchant critique of what he calls "the heresy underlying most modern English versions of the Bible," namely, "the use of translation as a vehicle for *explaining* the Bible instead of representing it in another language, and in the most egregious instances this amounts to explaining away the Bible." I have shared Alter's exasperation at times when comparing modern translations of the New Testament to the original Greek. Now I know first hand how difficult an art translation is at best; it always involves, unavoidably, interpreting the meaning of the original; and I admire and applaud the efforts of those who have produced the many versions of the last twenty-five years. But there is a fine line between interpreting and explaining, and I think that line has been often crossed in contemporary versions, sometimes with dubious results. Such dubiety also extends to annotations, as noted above.

[64]Nelson and Reynolds recommend other criteria for determining the relationship between biblical passages and scientific knowledge (ibid., 68–73). Their argument raises interesting questions, but this is not the place to address them.

[65]Ibid.

[66]*The Remarkable Record of Job*, chap. 3 *passim*. I say "whom" because Morris, apparently relying on some ancient rabbinical speculation, believes that Job is the original author of the book, and that we have a version edited by Moses (ibid., 16–9). For a more judicious evaluation of date and authorship, see Pope, xxx–xxxviii.

[67]"Letter to Marcellinus," 143:7 (*A Select Library of the Nicene and Post-Nicene Fathers of the Christian Church*, ed. P. Schaff [Reprint. Grand Rapids, MI: Eerdmans, 1979], 1:492).

[68]I accept the notion that a text may mean more than the author intended, but I also agree with Augustine that what the sacred writer did intend is "more worth knowing": *De genesi ad litteram*, I.19.38 (*The Literal Meaning of Genesis*, trans. John H. Taylor, S.J., *Ancient Christian Writers* 41 [Matwah, NJ: Paulist Press, 1982], 42). The issue here is whether the interpretations Eastman, Morris, and Sarfati have put forth are justifiable on philological and other grounds. I have argued that the evidence is clear that they are not.

[69]Luis Stadelmann, S.J., *The Hebrew Conception of the World*. Analecta Biblica 39 (Rome: Biblical Institute Press, 1970) provides a comprehensive survey and analysis of all of the references to the creation in the Hebrew Bible. For a succinct outline, with key references to Scripture, see Lloyd Bailey, *Genesis, Creation, and Creationism* (Matwah, NJ: Paulist Press, 1986), Appendix XI. I use a modified version of Bailey's outline in my course. There is also much useful information on the heavens, the earth, and the deep in some of the theological lexica cited above: on *shāmayim*, see the articles by David T. Tsumura, NIDOTTE, #9028, 4:160–6 and J. A. Soggin, TLOT, 3:1369–72; on *'erets*, see M. Ottosson, TDOT, 1:388–401 and H. H. Schmid, TLOT, 1:172–7; on *tʰhôm*, see Claus Westermann, TLOT, 3:1410–4.

[70]"The Bible and the Earth's Sphericity" posted on the Creation Research Society web site: <www.creationresearch.org/creation_matters/>.

[71]I am grateful to Bob Suder and my anonymous readers for their comments and suggestions.

The Functions of Introns: From Junk DNA to Designed DNA

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The research on functions for introns in the cell is reviewed. Darwinists once generally argued that nonprotein coding DNA are relics of once-functioning genes or useless "junk" DNA that strongly argued against design of the genome. The fact that an enormous quantity of cell resources and energy is invested in these putative vestigial structures, especially in the complex intron splicing mechanism, argues that introns have important biological functions including a means of facilitating genetic diversification. Evidence now exists that introns have many functions, including for regulation and structural purposes, and that many of the roles now hypothesized for introns are plausible but need further elucidation. The author concluded that the new knowledge related to introns supports the intelligent design world view.

The past decade has witnessed an explosion of discoveries in the area of molecular biology that has numerous practical and major implications for the creation-evolution issue. A critical requirement for evolution is the existence of large sections of extra nonfunctional DNA that can mutate to produce potential genes upon which natural selection can act. Bacteria usually contain only a few thousand genes (*E. coli* has 4,253), and humans have about 35,000. Consequently, evolution from protobacteria to humans requires a mechanism that can add functional genes.

One currently popular hypothesis to account for this increase in the genome size is that they are the remnants of the original development of genes, or that many DNA bases were added during evolution through such sources as viruses or inappropriate DNA duplication.[1] Called evolution's fuel, the theory argues that extra DNA allowed natural selection to gradually convert some of the nonfunctional DNA into functional genes.[2] The redundancy theory requires the organism to possess extra DNA in addition to its functional genes to allow it to evolve new genes that can produce new protein and cell structures. The redundancy theory suggests that most genes were once noncoding DNA and/or nonsense genes that produced nonfunctional protein which was either useless and rapidly recycled or caused harm to the cell.

Production of nonfunctional protein would result in a tremendous waste of cell energy and materials both in manufacturing the useless proteins produced by evolving genes and as a result of their being cut up and recycled by the cell's proteolytic system. Proponents of the redundancy theory speculate that some of these nonsense genes eventually produced a protein that conferred a survival advantage on the organism that possessed it. Last, natural selection fine-tuned the DNA and caused the protein it produced to become increasingly useful to the organisms' survival. For this process to occur, a large number of nonfunctional coding genes *must* have existed. Furthermore, without sufficient genetic raw material, evolution could not occur by this process. Much raw material must have existed and evolved into coding genes that produced a phenotype which conferred a selection advantage to the organism.[3] This belief is supported by the belief that an estimated 95% or more of eukaryote DNA has either nonprotein-coding functions or no known function at all.

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The DNA sections that have no known function are used as evidence for this theory. Nonfunctional DNA not only provides the raw material required for evolution, but it supports the Darwinist's view that the genome shows no evidence of design. Evolutionists reason that an intelligent designer would not produce a genome containing long sections of useless DNA that waste enormous amounts of materials and energy by duplicating huge sections of nonfunctioning DNA during each cell division that build useless (or even harmful) proteins. Sagan and Druyan state: "Some, maybe even most, of the genetic instructions must be redundancies, stutters, untranscribable nonsense ... [which prove that] deep imperfections [lie] at the heart of life."[4] This view also supports the position that evolution is a blind, purposeless process except if it facilitates an organism's ability to pass on its genes.

This view must be evaluated in light of the fact that the history of science is replete with now discarded theories that once supported Darwinism but increasing knowledge has rendered obsolete. Examples include vestigial organs (the claim that in humans 180 organs and structures were evolutionary leftover's such as the pineal and the thymus), atavisms (the theory that certain conditions such as trisomy 21 were evolutionary throwbacks—trisomy 21 persons were called Mongolian idiots for this reason), and the biogenetic law (the belief that the embryological development of an organism passes through its evolutionary history). Likewise new research is beginning to overturn the view that most of the genome has no function. This is reflected in the following comment on the Sagan and Druyan statement cited above:

> Such comments are commonplace in the biological literature—although perhaps less common than they were a few years ago. The reason? Geneticists are discovering functions for what used to be apparent genetic debris.[5]

In contrast to the requirement of evolution for large amounts of useless DNA, the research explosion on DNA has revealed evidence that much of this DNA is necessary, or even critical, for life. Although many of these studies are preliminary, and many other uses for noncoding DNA likely will be found in addition to those noted here, most recent discoveries support the design world view. Recent research also supports the view that, though over-designed (viz., possessing more information than is necessary for survival) the entire genome is or once was functional and exists for a biological purpose—a conclusion that supports the intelligent design hypothesis.

Introns

The two major divisions of DNA that are transcribed into RNA are protein-coding sections called *exons*, and nonprotein-coding sections called *introns*. Introns consist of large stretches of DNA whose biological functions are only beginning to be elucidated. All genes begin with exons (the protein-coding segments), but most have a variable number of introns within them that alternate with the exons. Introns were discovered in 1977 as a result of observing that the mRNA used to code for proteins was almost always *shorter* than the DNA from which it had been transcribed.[6]

The mRNA was eventually found to be shorter because it lacked the *noncoding* sequences (introns) between the coding regions (the exons) on the DNA.[7] It was discovered that introns were normally removed by splicing enzymes before mRNA (messenger RNA), rRNA (ribosomal RNA) and tRNA (transfer RNA) can complete their functions in the cell. Because introns interrupt the nucleotide sequences, they first were called *interrupted genes*. The "int" in intron refers to *intervening* because introns always exist between exons. In eukaryotes, intron removal and splicing is completed within the nucleus. Sequences that code for protein are called *exons* because they travel (exit) outside the nucleus to code for proteins, and thus are the DNA sequences that are *expressed* (the prefix *ex* in the term *exon* is from expressed).

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The Process of Removing Introns Shows Evidence of Design

When mRNA is transcribed from DNA (Figure 1), both the exon and intron noncoding sequences are transcribed into a macromolecule known as a *heterogeneous nuclear RNA* (hnRNA), or immature RNA. Before the RNA exits the nucleus, the introns must be removed by a precise cleavage-ligation reaction called *splicing*, thereby producing a functional mRNA.[8] Enzymes and small ribonucleoprotein structures exist in all eukaryotic cells to assist in removing introns. In most cases, type I introns are removed in the nucleus by a complex splicing machine composed of *small nuclear ribonuclear proteins (SNRP)*. SNRPs consist of 60–300 small nuclear RNA (snRNA) nucleotides in an "intimate alliance with a bouquet of proteins."[9]

The process of intron removal involves a precise looping process controlled by a specific nucleotide sequence that abuts the exons.[10] Almost all known introns are identified by specific *consensus sequences* [GT at the start or *donor* (3′) end and AG at the other end, called the *acceptor* (5′) site] which help to identify introns for removal. The term "consensus sequence" is employed because, although the sites may consist of more than just GT donor and AG acceptor bases, so far as is known these sequences are common to all eukaryotic organisms.[11] Consensus sequences are DNA segments that use similar base sequences in different genes within a single gene family or across many different species for one specific function.

After the introns are cut out, the exon RNA is spliced back together by *RNA ligase* so that the final mRNA used to code polypeptides normally consists only of exons. In Type II introns, RNA itself functions as an enzyme called a *riboenzyme* or *ribozyme*. These enzymes require a divalent cation (usually magnesium) to function. The process of removing introns involves a complicated reaction pathway

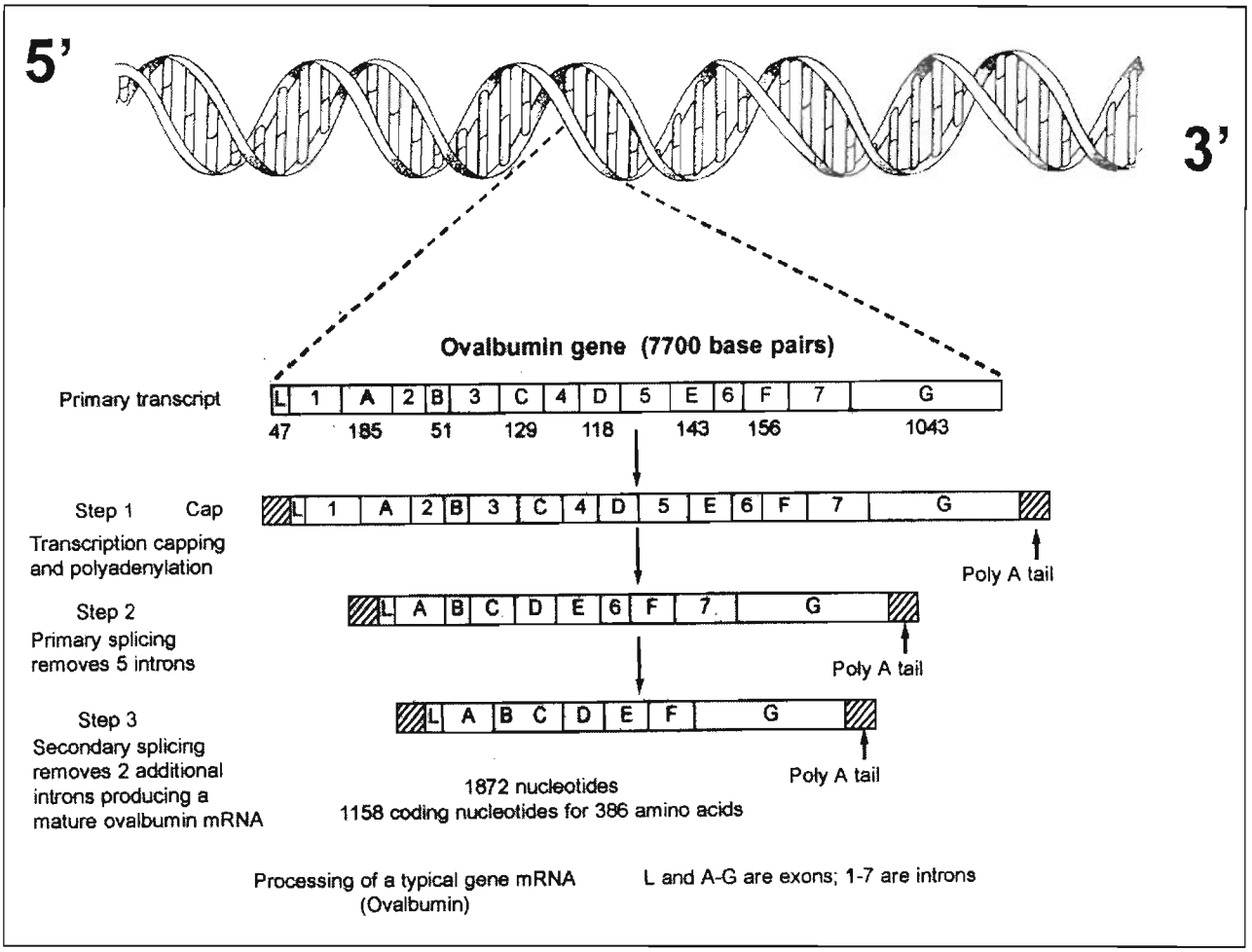

Figure 1. Noncoding Genes. Drawing by Richard Geer. Adapted from Anatoly Bezkovainy and Max E. Rafelson, Jr., *Concise Biochemistry* (New York: Marcel Dekker, Inc., 1996).

that includes RNA intermediates called *lariats*, branch connecting points, and a large number of accessory proteins.[12]

Number and Length of Introns

The sections of the human genome sequenced thus far provide an estimate of the genome's composition. It appears that over 90% of the DNA bases consist of repetitive noncoding regions, introns, and regions between genes that have no known function.[13]

The number of introns in transcribed RNA ranges from zero in histone genes to an estimated 2.5 million bases in the protein dystrophin.[14] The dystrophin gene has over 75 introns and only 0.5 per cent (11,000 bps) of the gene consists of exons.[15] A defective dystrophin gene is the major cause of Duchene Muscular Dystrophy. Another example is approximately 98% of the gene that causes cystic fibrosis consists of introns.[16] The large number of introns in the genome is revealed by evidence that indicates the *majority* of base pairs in *most* genes consists of introns. The length of one intron varies from 31 nucleotides in an SV-40 gene to over 210,000 in the human dystrophin gene,[17] although 65 to 20,000 nucleotides is more typical.[18]

Roles of Introns in the Cell

Indications that introns have a use include the observation that "the cell puts a huge amount of its energy into the creation of these introns, then discards them ... Nature would not go to all that trouble without a reason."[19] Why "most genes of higher organisms are broken up into short exons separated by huge stretches of seemingly useless DNA" is particularly puzzling because "the introns are all painfully transcribed into RNA only to be snipped out by snRNPs and thrown away almost immediately."[20] Evolutionist Patrusky says: "Nature, for reasons as yet unknown, created the intron, and evolution has chosen to keep it ... and ultimately has found new ways to use it."[21]

An important finding which may help researchers to understand the role of introns is the more primitive and simple the organism generally the fewer the introns. Although the majority of plant and animal genomes have not yet been examined, introns have been found in the vast majority of eukaryotic genes and likely exist in all eukaryotes.[22] Wills speculated that fewer introns exist in prokaryotic organisms because bacteria need streamlined genomes, or may have less need for whatever functions introns serve. He also speculated that the putative early organisms may have lost their introns through evolutionary development.

The fact that all higher organisms possess introns, and the more complex organisms possess a higher proportion of introns, indicates that they serve at least minor, and possibly major, functions. Wills says: "Carrying this enormous extra baggage of unnecessary DNA each generation seems a heavy price to pay for the privilege of the occasional bout of exon shuffling."[23] Many reasons now exist to conclude that introns are not found in cells only because they are "intrinsically capable of replication and therefore can stick around" as once believed.[24] Furthermore, research has found a high level of conservation in some introns, indicating that they have some selective advantage, that is a useful function.[25] How many introns display this conservation is not yet known.

This raises the question, "If introns produce a major selection advantage and consequently are characteristic of higher, more developed organisms, what could explain their loss in lower organisms?" Variety is critical for species survival, and producing variety is especially difficult in animals with small genomes, the very creatures which must have possessed the variety required by evolution in order to evolve. Putative ancient bacteria evidently would possess little capacity for variety if the absence of introns (and other structures) in modern bacteria was also the situation in early bacteria.

The former belief that introns were useless was once so prevalent that many felt it would be a major waste of resources for the human genome project to sequence these long stretches of "meaningless DNA." The human genome project involves sequencing the estimated 35,000 genes and over three billion base pairs at a cost of over $3 billion.[26] The National Science Foundation priority is now on sequencing exons, but eventually the entire code will likely be determined partly because of accumulating evidence that the entire genome has a function. A problem in genetic research is that genes in which introns are left in may be so long and unwieldy that they cannot be carried by a vector virus or plasmid. When the significance of introns is understood better, this problem can be dealt with more effectively.[27]

The New View of Introns

It is now recognized that introns are "a complex mix of different DNA, much of which are vital to the life of the cell."[28] As their functions are being determined, the relationship of introns to cancer and their use as tumor markers is also being explored.

Several functions for introns have already been identified, and evidence for a role for them is indicated by the finding that some intron alterations are directly related to the development of cancer.

Early insight in intron function was a result of the finding that many noncoding DNA sequences are not random base pairs, but have certain features in common with human language.[29] The finding that introns manifest the same complex patterns of communication found in human speech supports the supposition that they carry functional information. Of course, the existence of a pattern does not in itself provide direct evidence for a function, but it does indicate a potential systematic cause exists which produces the pattern found.

Alternative Splicing

The problem of identifying introns was compounded by the discovery that alternative readings of the genetic code exist in which "introns" function as exons.[30] Some DNA behave as exons when expressed by one pathway, but as introns when expressed by another pathway.[31] Both pathways can operate simultaneously, resulting in greater protein product variety.[32]

Termination codons are also sometimes deliberately bypassed, allowing the coding of a part of an intron in order to produce a specialized protein. Variations in intron removal splicing patterns can be used to create two or more distinct mRNAs which code for different polypeptides. This allows one mRNA code to be used to produce a variety of polypeptides.[33] Splicing variations are controlled by regulator proteins designated as *SR proteins*. SR proteins determine which splicing pattern predominates in a specific cell at any given time.[34]

Another example of an alternate reading system that can make use of introns is *frame shifting*, which causes the normal grouping of nucleotides to be altered so that the DNA is read in a completely different way. A third type of alteration which may involve introns is *base hopping* in which large DNA segments are skipped when the mRNA is produced. These observations reveal that genes are far more complex than our earlier understanding of the genetic code first indicated.[35]

Some introns also function as control sequences in the process of chromosome X inactivation which is necessary for dosage compensation in females. The *Sxl* gene is the master regulator in the sex determination pathway of some organisms and functions by regulating how the introns are cut out of mRNA. It produces a functional protein only in females that culminates in the development of female structures.

The *Sxl* gene is also critical for dosage compensation by blocking *mle* and *msl* genes, which make a protein that increases certain X chromosome proteins.[36] *Sxl* functions by blocking removal of the introns in females, preventing females from producing functional *msl*-2 protein. The *msl*-2 gene is also controlled by removal of an intron in males, but not in females.[37] Males lack an *Sxl* gene, and therefore process the msl-2 transcript properly:

> The fruit fly provides an interesting example of two-way mRNA splicing. In this animal, the differences between males and females are controlled by two sets of regulatory proteins, one set specific to the male and one to the female. The two sets of proteins are coded by the same set of genes; the sex differences are largely due to different patterns of RNA splicing.[38]

Nested Genes

Some introns have been found to be separate genes located *within* the reading frame of introns and are often transcribed from the *opposite* direction as the introns. Many examples have been found, and likely many more exist. The neurofibromatosis type I gene contains three nested genes, all transcribed in the direction *opposite* that of the gene.[39] These three nested genes appear to have no functional relationship to the neurofibromatosis gene. An intron in the blood clotting factor VIII gene in the human X chromosome contains an embedded gene that is also transcribed in the opposite direction, and a *second* embedded gene that is transcribed in the *same* direction as factor VIII gene.[40]

The discovery that some DNA function as exons when expressed by one pathway, but as introns when expressed by another, blurs the distinction between introns and exons. The finding that nucleotides cut out introns in one splicing pattern which become part of the functional mRNA as exons in another splicing pattern also indicates that a precise method to differentiate introns from exons exists.

Another possible example of a control function for introns was inadvertently discovered from research on transgenes developed for gene therapy. In endeavoring to replace a malfunctioning gene with a normal allele, a research team headed by Oliver Smithies of the University of Wisconsin removed the introns after they had determined that the genes were not expressed. They found that "the shortened versions of the HPRT gene commonly being used in such experiments worked very badly

in cells recently taken from mouse embryos, although they did work well in cells taken from mice years before and grown in culture."[41] Conversely, when the researchers *left in the introns*, they found that the genes worked properly in "fresh" cells. This research indicates that at least some introns may have an important role in controlling the expression of exons.[42] Whether this putative regulation system affects tumorigenesis is unknown.

Although introns are routinely edited out, Ron James and his team at Pharmaceutical Proteins Ltd. injected mouse eggs with an alpha-1 antitrypsin gene that included some of the introns in transgenic sheep. James states: "We left some of these random bits of DNA in the gene, essentially as God provided it," and as a result "high yields resulted."[43] In this case, the introns enhanced the production of protein, resulting in a breakthrough crop of transgenic sheep. This research also supports a facilitator role for introns.

Many diseases are caused by mutations in the noncoding portion of the gene, such as in the flanking or start-stop sequences. Examples include hemoglobin diseases caused by damage to a noncoding section of DNA that contains sequences identical to the normal hemoglobin exons. The hemoglobin protein produced by the gene evidently will not function if a mutation occurs in certain non-exon DNA.[44] Other noncoding portions also have an impact on the organism's function, and it is possible that the introns have a role in reducing or correcting these mutations.

Regulatory Role of Introns and Cancer

At least a dozen studies shave found evidence that introns are either directly or indirectly involved in cancer causation. Examples include evidence that introns are involved in transcriptional regulation of apoprotein B, E, and A-II[45] and that introns may be involved in regulating neoplasm development.[46]

Cytolytic T lymphocyte clones used to study melanomas found the gene coding for the antigen recognized by the cytolytic T lymphocyte was the same gene which codes for N-acetylglucosaminyltransferase V. The antigenic peptide recognized by the cytolytic T lymphocyte was found to be encoded by a sequence located *inside an intron*. The researchers found that the mRNA containing the introns coding for the antigen was *not* found at significant levels in *normal* tissues but was observed to be present in close to half the melanoma tissues studied. The researchers concluded that a promoter located near the end of the relevant intron was activated in melanoma cells, resulting in the production of an mRNA that codes for the antigen.[47]

Defective glutathione S-transferase and N-acetyltransferase enzymes have been associated with an increased risk of developing both lung and bladder cancer. The research results are inconsistent, though, and several studies have failed to find associations. According to some studies, the lung cancer risk is elevated up to 40-fold in subpopulations that contain both the high-risk cytochrome P-450 type A1 and glutathione S-transferase M1 genotypes which are a result of mutations in introns or other silent areas of DNA. One study on the glutathione S-transferase M3 gene found a mutant three-base deletion in intron 6 of the wild type glutathione S-transferase allele.[48] This defect may be related to neoplasm development, but exactly how is unknown.

Megonigal, et al. used panhandle PCR to clone MLL genomic breakpoints in two pediatric treatment-related leukemias.[49] The panhandle PCR identified a fusion of MLL intron 6 with a previously uncharacterized sequence in MLL intron 1 which the researchers concluded was consistent with a partial duplication. The breakpoints in both cases were located in Alu repeats, suggesting that the Alu sequences were an important contributor to the rearrangements they found.

Malkinson and You have hypothesized that introns of genes whose products influence tumor development can affect cancer incidence and that

> a large number of regulatory mechanisms ... control key growth and differentiation steps: ... The ability of each of these host defenses to withstand mutation and a consequent loss of function may be controlled, in part, by their intronic structure. Proto-oncogenes, tumor suppressor genes, cell-cycle regulatory genes, simmune defense systems, and the protease/antiprotease systems that influence metastasis are all candidates for having polymorphisms within their introns that affect gene behavior.[50]

Conclusions about introns and cancer are difficult for several reasons, including the fact that it must be determined if mutations in the introns actually contribute to tumorigenesis progression, or if this damage is a result of collateral or unrelated damage. The associations found between introns and cancer may occur by chance, or it may be due to an unknown role of introns or other putative silent areas of DNA. Numerous other studies indicate a regulatory function for introns:

> Introns are becoming more widely recognized as having important gene-regulatory roles, such as containing enhancer or silencer elements. While many intronic polymorphisms may be of trivial consequence ... we believe that variation in the number of intronic 37-bp copies in the K*ras* will serve as an interesting model system for examining how inherited variations in the copy number of oligonucleotide regions within an intron affect the etiology of diseases.[51]

Among the many other intron genetic variations that have been linked to cancer (in this case lung cancer) is a K-*ras* intron variation involving tandem repeats in the H-*ras* 3′-untranslated region.[52] Mutations in introns may influence neoplasm development because mutations that occur in introns (or in the DNA sequences that flank the gene) can affect the various steps required for normal expression of the gene even though the intron codes may not be detectable by studies of the protein product of the gene.[53] If the defective expression of a gene product is a tumor suppressor gene or a proto-oncogene, cancer may result.

Regulatory functions of introns may involve controlling gene activity in different developmental stages or responding to immediate biological needs by controlling local gene expression.[54] This function of introns could occur if, as one theory indicates, exons code for a *domain*, a polypeptide unit that has a discreet function such as binding to a membrane, or to the catalytic site of an enzyme or serving as a structural unit of a protein.

Some evidence also exists that introns structurally stabilize the pre-mRNA to protect it against degradation. Margulis and Sagan noted that DNA is packed into a chromosome so effectively that it is 1/8,000 of its former size after packing.[55] They concluded from studies on ciliates that at least some introns, and possibly other noncoding DNA, may be involved in DNA packaging in eukaryotes and perhaps in some prokaryotes.[56]

Exon Shuffling

Introns also produce a critically important life trait called phenotypical variety by regulating or facilitating the transposition of exons.[57] Evidence for this role includes the observation that introns commonly are located at or near the boundaries between different domains in the DNA molecule. Called *exon shuffling*, this mechanism helps to produce genetic and phenotypical variety in an organized way by producing new exon combinations and thus greater genetic diversification. This would enable the production of a variety of polypeptides from a single gene.

Bryk and Belfort concluded that ectopic crossovers (nonspecific pairing of DNA) could cause shuffling to occur in an open reading frame so that "double crossovers between separate elements" resulted. They suggested that this process would "extend the range of viable recombinational possibilities because they leave undisturbed the regions between the homologous elements."[58] This finding supports the conclusion that some introns act as recombinogens that function to increase the level of genetic exchange and consequently controlled phenotypic variety.

Introns may also contribute to greater genetic diversity due to their role in crossing over, which is one of the "main sources of genetic variety in eukaryotes."[59] The role of introns in producing genetic variety includes the lengthening of a DNA strand considerably, thereby increasing the number of points where crossing over can occur between two gene alleles. Introns may also assist in the recombination process to ensure that exons are shuffled in an orderly manner to produce appropriate exon combinations.

Another role for introns in producing variety involves introns related to retroposon elements that are able to move DNA from one part of the genome to another in a way similar to how retroviruses (including HIV, and many cancer viruses) function. Retroviruses carry a gene that produces a reverse transcriptase enzyme that codes DNA from mRNA. Introns accompanied by flanking exon sequences use a highly efficient homing process to move to its intron-less alleles at efficiencies approaching one hundred percent.[60] Specific mechanisms that introns use to achieve this still are not understood. Although some introns resemble transposable genetic elements, most do not. The function of introns to produce phenotypic variety could support both an intelligent design interpretation (they are complex designed mechanism that produce limited variations in certain structures) or evolution (they provide variety for natural selection to operate on). Functional theories argue that introns and other noncoding

> DNA has a sequence-independent function by virtue of its sheer bulk. Most functional theories assert that cell size is adaptively important (for which there is much evidence;[61]) and that the genome-size-cell-volume relationship is the key to explaining the continued presence of non-coding DNA. The most specific of the functional theories is the skeletal DNA hypothesis, which states that the mass of DNA (in conjunction with its folding pattern) directly deter-

> mines the nuclear volume. In order to maintain a balance between the rates of nuclear RNA and cytoplasmic protein synthesis during growth ... cells of differing volumes must have a constant cytonuclear ratio.[62]

This ratio tends to be optimized in all cells because of certain cellular requirements. Cavalier-Smith have found that their functional theory applies to both unicells and multicells, but its application to the latter is more complex due to the extra complications in multicells and protists with multiple nuclei or multiple fission.[63]

Conclusions

Various known and possible functions of noncoding DNA were briefly reviewed with special emphasis on introns. The research reviewed in this paper has caused a number of investigators to conclude that the hypothesis, that large amounts of DNA are nonfunctional, may be erroneous. As research continues to elucidate the structure of the genome, it seems that most DNA will be found to have a function, although some DNA no doubt will prove to be more important than other DNA. Furthermore, some useless DNA which has little effect on survival may be a result of corruption of genes due to entropy. Some useless DNA may also be the remains of virus or transposon DNA inserted into the chromosomes in the past.[64]

No clear evidence yet exists that introns support an evolutionary origin for the genome. It appears that problems develop with noncoding DNA only when mutations or other damage to the system occurs. We now know that DNA sequences not only carry information for making proteins, but also play many supportive roles in protein synthesis including manufacturing transfer RNAs that help to assemble amino acids into proteins and rRNA, as well as other forms of RNA.

In the past, evolutionary geneticists, once uncertain as to what this apparently superfluous DNA does, referred to introns and other noncoding DNA as "junk." Evidence is now being accumulated which indicates that much or most of this DNA may not be junk, but critical for life itself.[65] If functions for most or all of the noncoding DNA is found, Darwinism would be without the raw material needed to produce new genes by mutations that can be selected for evolution to occur. Furthermore, much of this new information on the complexity of the genome elegantly provides evidence for both intelligent design and for the concept of irreducible complexity. ✻

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[65]A. F. Smit, "The Origin of Interspaced Repeats in the Human Genome," *Current Opinion in Genetics & Development* 6, no. 6 (1996): 743–8.s; G. Berx, F. Nollet, K. Strumane, and F. van Roy, "An Efficient and Reliable Multiplex PCR-SSCP Mutation Analysis Test Applied to the Human E-cadherin Gene," *Human Mutation* 9, no. 6 (1997): 567–74; M. S. Clark and W. J. Wall, *Chromosomes* (London: Chapman and Hall, 1996); and K. F. Schmidt, "A DNA Structure that Tags Genetic Junk?" *Science News* 144 (1993): 21.

Communications

Creative Providence in Biology

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Theists agree that, ultimately, God is the Creator of everything. And they agree that he graciously and continuously provides for the needs of all his creatures. There is much uncertainty and disagreement, however, about the how of his creating and providing. Some think he intervenes occasionally or often, others believe he initially created a gapless economy of parameters and natural laws which take care of everything. I propose that both theological and scientific indications point to a continuous, active, but usually hidden involvement of the Creator in all that happens.

Roughly speaking, the Bible tells us about the Creator, and science tells us about his creation. A theist needs to integrate the two aspects. The book, *God Did It, But How?* by Robert Fischer deals with creation,[1] but the idea applies to providence, as well. Biblical theology clearly presents God as both Creator and Provider. *How* might he have created and *how* might his providence work? Has he ceased creating after an initial creation? And *how* is his continuing providential work to be understood?

Creation's "Functional Integrity"

Howard Van Till has presented his concept of "creation's functional integrity."[2] He insists that God created a universe which from the outset had functional integrity, in the sense of being capable of producing everything God wanted it to produce at the appropriate time, without requiring any further "intervention." Van Till is not a deist believing this left God with "nothing to do" afterwards. In biblical theology, God is not only the Creator of the universe, but he also continually upholds all of his creation,[3] actively keeping it in existence. Of course, God is capable of performing any "supernatural" acts he chooses to do ("miracles"). But he is just as much the Author of any of the "natural" processes science is able to investigate. Therefore, it is not meaningful to talk about God "intervening" in the created order, as if his hand was not already in it anyway. But his creation is evolving "naturally," and it is he who made it do so. Whatever evolutionary processes occur in the history of the universe or of life are acts of God. Van Till's view of creation's functional integrity for the development of the universe may be essentially correct—in the physical realm.

The emergence of biological information, however, cannot be dealt with in the same way. Biological systems, starting at the molecular level, are extremely complex, requiring a large amount of information for their full specification. When and how did this information originate?[4] Did it spontaneously arise each time some new biological structure or function evolved, or did it emerge all at once at the origin of life, or was it created at the origin of the universe? On the basis of what is known, all of these options are unconvincing. A spontaneous emergence of all biological information out of the environment appears implausible,[5] and its having been stored ahead of time in a prebiotic universe even more so.

Van Till includes the biosphere in his concept of functional integrity. Apparently, he does not deem the origin and evolution of nonliving and living systems (even human life) to require different treat-

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ments. Does this imply that all biological structures, functions, and species developed spontaneously and inexorably by physicochemical necessity and chance? Van Till does not call the emergence of biological systems autonomous, but considers all of it to be decreed by God from the beginning. However, with his concept of functional integrity, it would have been autonomous in the sense of not requiring anything God had not yet "gifted creation with from the outset." God certainly could have done it this way if he had chosen to do so. But as with the statement that he could have created every species *de novo*, the question is not what God *could* do, but what he did.

Van Till's view necessarily implies that most of the information required for the structures and functions in the biosphere, including humanity, was either contained in the energy, strings, plasma, or whatever of the early big bang – and in the prebiotic universe ever since, or that it emerged by self-organization out of nothing – which is what is usually claimed. From what is known in the biological sciences, it appears preposterous to believe in either possibility. Curiously, Van Till seems to prefer the first version, explicitly including "biological systems" among the "basic entities" which God "from the beginning, when the creation was brought into being from nothing," gifted with all of the capacities needed.[6] Yet biological systems did not come into existence for over ten billion years. What and where were these systems with their capacities before the origin of life? If their blueprints were not stored in the physical universe, but in the mind of God, then what is the difference from saying he introduced this information at the appropriate time – first into the prebiotic Earth's crust, ocean, or atmosphere and later into the biosphere? As for the other version, to date, the talk of "emergence of information by self-organization" is not supported by any relevant theoretical, observational, or computational evidence and is therefore rather vacuous.

God's Hidden Options

What could be the source of information for the origin and further development of life? I do not suggest any divine "interventions" through "gaps" in the sense Van Till rejects. For theological reasons, I believe that God "hides his footsteps" in creation to protect the personal freedom he has chosen to give us so that we can make a faith decision for or against him.[7] His footsteps in creation are plain, but only to those who choose to believe; to others, their evidence is ambiguous. As for those who believe in self-organization of the biosphere, their faith in miracles in chemistry and molecular biology is amazing. Therefore, miraculous interventions are not to be expected on theological grounds, but autonomous events of transastronomical improbabilities are scientifically unbelievable. What alternative possibilities could be envisioned?

There are plenty of "gaps" of knowability which can never be bridged by science, not just for the present, but in principle. They are fundamental impossibilities for science. But God is free to act everywhere – where scientific investigation is possible, and where it is not. In order to clearly distinguish these limits from the gaps of "god-of-the-gaps" views, I prefer to call them God's "hidden options." To be more specific, they may include quantum uncertainties, randomness in elementary events, unpredictability due to minute parameter value deviations in nonlinear systems liable to produce deterministic chaos,[8] and coincidences. For instance, the spontaneous occurrence of a specific combination of mutations required for the emergence of a certain enyzme activity may, in context, be transastronomically improbable. Even so, we can never prove it impossible, as the tails of the Gaussian probability distribution extend to infinity. Yet God may have chosen to actively decree it to occur.

Such "hidden options" do not represent acts of "special creation" in the sense of exceptions to any natural law. Rather, they are specific acts of *selection* among distributions of many different naturally possible values for stochastic variables. The only thing that is "supernatural" about them is the fact that selecting specific events means feeding information into the system. The physical system does not display any lack of functional integrity, but it needs information, just as a fully functional computer requires software, data, and input events to do any useful work.

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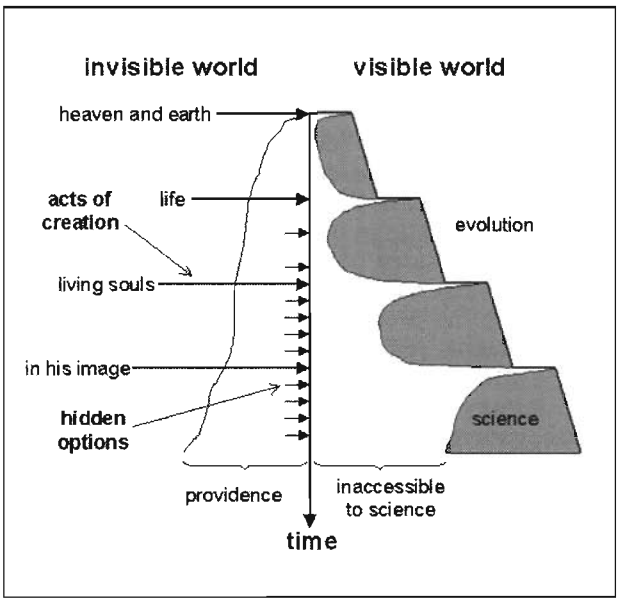
Of course, the only reasonable interpretation of such a hidden source of biologically meaningful information is the Creator. Intelligent design in biology cannot be divorced from God.[9] How often such hidden acts of selection would occur is another question. It seems to be very difficult to answer. I believe the biblical Hebrew term *bara'* (to create) would correspond to God's introducing new information. Of course, it occurs in Gen. 1:1, where it refers to the initial creation of the universe, but it is also used in various other contexts. The Old Testament explicitly applies it to God's creating individuals—not only humans,[10] but even animals.[11]

No God-of-the-Gaps

The "hidden options" suggested are very different from "god-of-the-gaps" speculation:

1. There is no logical reason, either scientific or theological, for excluding such hidden options in principle.
2. They are claimed for scientific reasons, not theological ones.
3. We know from science that these fundamental limits for scientific investigation exist.
4. They are not research-stops, but just honest admissions of ignorance in place of obfuscating just-so stories.
5. They avoid the gratuitous appeal to future science, which is very vaguely and optimistically expected to be able, some day, to bridge gaps in our present knowledge.
6. They are not gaps in which a usually inactive god would exceptionally intervene.
7. They are not gaps in God's initial plan, but from the beginning a part of what he presumably intended to do at the appropriate time, in addition to his activity in the processes open to scientific enquiry.
8. They are not gaps in "creation's economy" as all materials and their properties were fully in place and well equipped to proceed anywhere in development, just sometimes in need of the specific direction required (being, for lack of time, unsuccessful in mere random-walk trials).



God's Actions and Scientific Investigation.

Simplest Biopolymers Are Transastronomical

The reason why random mutations, followed by natural selection, cannot produce all biological functions and an entire biosphere is the huge size of the possibility space; for biopolymers, such as DNA and proteins, this is sequence space. The tandem of random mutation and natural selection is too inefficient, especially in the starting phase of the evolution of a new function, when selection coefficients are small or even nonexistent. In the latter case, random walks are free and unselected, so that their probabilities can be estimated. Most protein domains are about one hundred amino acids long.[12] But even the sequence space of those as short as 62 amino acid residues comprises $20^{62} > 10^{80}$ different sequences. As the known universe contains about 10^{80} nucleons, the protein domain sequence space is therefore transastronomical, such that it cannot be productively searched by any random processes.

Proteins performing the same function in different biological species usually have similar sequences. It is reasonable to assume that those features of these sequences which are invariant in all species are required to perform the common function. The simplest version of this invariant set is the number of invariant amino acid placements. As in some other positions restricted groups of similar amino acids can replace each other without loss of function, appropriate fractions of one have to be added for each of them.[13] The size of known invariants is about 30% of the number of amino acids in the sequence, although the percentage varies. To be more precise, one should take into consideration any species-specific requirements, but these are usually unknown.

The invariant being smaller than the entire protein, the possibility space for a specific biological function is very much smaller, and the probability that any one of the acceptable sequences is accidentally produced is much larger than for a unique sequence. Yet, the possibility space of the invariants of proteins containing two small domains of one hundred amino acids each is again transastronomical. But the average protein size is perhaps twice as large. Therefore, in principle it is impossible to demonstrate that a belief in spontaneous evolution of today's biosphere is plausible—unless it can be shown that very much smaller "primitive" precursor systems are functional.

Even Mini-specifications Inaccessible

Proteins more "primitive" than the modern ones may have displayed much smaller invariants and correspondingly weaker and less specific functions. The minimum of any invariant can only be reached by means of a nonselected mutational random walk, since before that point, there is nothing to be selected, as far as the activity required is concerned. What is the size of such a minimal invariant? The only proteins we know are the highly specific modern ones. An attempt to design a miniaturized redox enzyme has not yet achieved its goal.[14] The undecapeptide dimer synthesized can hold an iron atom, but the complex lacks the stability required, being too small to shield off the environmental water. So far, its invariant may be at least about five; it will be larger once the protein is functional. But the largest invariant attainable by nonselected mutational random walks on Earth within three hundred million years was estimated to be between two and three only, even with wildly overly optimistic assumptions.[15]

In order to find out whether a belief in spontaneous evolution of the biosphere is plausible, the best we could hope for would probably be to design and synthesize a feasible initial substrate for Darwinian evolution, namely a functional, self-replicating mini-organism comprising a minimal set of miniproteins of minimal activity only, each of which requires an invariant of less than three, or an equivalent RNA organism. Those familiar with origin-of-life research know that, in the foreseeable future, this goal is unattainable.[16] As life arose at least 3.8 billion years ago, such a mini-organism, with a genome much smaller than that of the simplest known bacteria, would have had to be available shortly after the initial catastrophic bombardment of the Earth with planetesimals ceased.

Are God's Creatures Perfect?

Are there any *theological* reasons for excluding God's "hidden options?" Van Till seems to suggest that it would detract from God's honor to admit that he created something in an unfinished or imperfect state. In a similar vein, believers in a young Earth maintain that everything that God created must have been perfect immediately, originating in sudden fiat creations out of nothing, as anything else would deny the absoluteness of his wisdom and power. Of course, Van Till's concept of functional integrity of creation does permit long developmental processes, but exclusively by "natural" means. But what is the theological justification for claiming such integrity not only for the Creator himself, but for created systems and processes?

Van Till appeals to the early church fathers, Basil and Augustine, who apparently arrived at a similar concept of a functional integrity of creation.[17] It is understandable that they felt that way. In their day, natural philosophy presumably still had a strongly platonic inclination, believing in eternal, perfect, ideal forms. As they knew nothing of the large-scale development of the universe and of life's complexity, Plato's idealism might have looked reasonable to them, just as they had no qualms believing in a spontaneous generation of some kinds of organisms. Yet, can we be confident that their idea of God being creatively active only once did not primarily rely on platonic idealism, but rather on biblical data? What are the biblical data in context?

Comparing with God's Revealed Ways of Acting in History and Revelation

The Bible often talks of God's acting in human history, but much less of his acting in the history of the universe and of life. Nevertheless, we may perhaps compare the two areas to some degree. God guided the history of his people by continuously shaping many big and small events. If it were not for the biblical proclamations that these events and developments represented God's direct action, one might attribute many of them to "natural causes," like human tendencies, coincidences, etc. In this sense, we may say that God used "hidden options," i.e., he did specific things in human history of which we know by revelation only that it was he who did them. Secular history or other sciences may, at most, tell us some of the natural aspects of these events, but nothing of God's primary agency.

Would the concept of creation's functional integrity applied to such events tell us that, from the outset, God preprogrammed all of history, down to a suitable level of details, into the physical universe, excepting only the modifications to be expected from some free will decisions by his creatures? There is no biblical indication for this. The Bible just tells us that God did it. Of course, God knows everything that is going to happen in the future, but preknowledge does not automatically imply predestination. God deals personally and individually with people in history.

Why should he not care to guide individual mutations and their selection? Apparently, he arranges births and deaths of individual animals.[18] As far as their individual origins are concerned, we are told that God creates them (the strong word *bara'*), presumably using "hidden options" in genetic and reproductional processes.

There are parallels between creation, revelation, and salvation. Each is done by God's Word, and each uses limited "natural" processes guided by God. In Jesus Christ, God "emptied himself" and "became flesh" in human weakness—this is his method of salvation.[19] But Jesus remained in perfect communion with the Father and in subjection to him, so the Father could guide him continuously. God's method of revelation had a similar character: the biblical texts were received, written, kept, copied, selected for canonization by fallible humans, thus introducing some weaknesses. But God guided the process, preventing mistakes of a relevant order. This same reality may well apply to his method of creation, too, in the sense that he did not create a platonically ideal system which works all by itself. He may have initiated processes developing in time, while imperceptibly guiding the system wherever and whenever it needed guidance. ⁂

Notes

[1] R. B. Fischer, *God Did It, But How?* (Grand Rapids, MI: Zondervan, 1981).

[2] H. J. Van Till, "Special Creationism in Designer Clothing: A Response to 'The Creation Hypothesis,'" *Perspectives on Science and Christian Faith (PSCF)* 47 (1995): 123; H. J. Van Till, "Basil, Augustine, and the Doctrine of Creation's Functional Integrity," *Science & Christian Belief* 8 (1996): 21.

[3] Hebrews 1:3.

[4] The amount of information a biological system can glean from the environment, by means of the process of mutation and natural selection, is vastly insufficient, and this process operates much too slowly.

[5] The arguments for this view were dealt with in P. Rüst, "How has Life and its Diversity Been Produced?" *PSCF* 44 (1992): 80, and again touched upon in A. Held & P. Rüst, "Genesis Reconsidered," *PSCF* 51 (1999): 231. Similar views have been expressed by R. Forster & P. Marston, *Reason, Science & Faith* (London: Concorde House, 1999).

[6] H. J. Van Till, "Special Creationism in Designer Clothing: A Response to 'The Creation Hypothesis,'" *PSCF* 47 (1995): 123.

[7] P. Rüst, "How has Life and its Diversity Been Produced?" *PSCF* 44 (1992): 80.

[8] G. P. Williams, *Chaos Theory Tamed* (Washington, DC: Joseph Henry Press, 1997).

[9] The claim of intelligent design theorists that the design inference rests squarely within science is, for biology, unconvincing; their examples are restricted to cases like archeology, forensics, and putative extraterrestrial intelligence: none has a prehuman and non-ET, or even a prebiotic reference. Cf. W. A. Dembski, *The Design Inference* (Cambridge: Cambridge University Press, 1998); W. A. Dembski, ed., *Mere Creation* (Downers Grove, IL: InterVarsity Press, 1998).

[10] Psalm 102:18; Isaiah 43:7; Malachi 2:10.

[11] Psalm 104:30.

[12] A domain is a part of a protein sequence folding into a discernable partial structure, often devoted to a specific aspect of the protein's function.

[13] H. P. Yockey, *Information Theory and Molecular Biology* (Cambridge, UK: Cambridge University Press, 1992), 129, describes the precise information theoretical procedure to be used.

[14] A. Lombardi, et al., "Miniaturized Metalloproteins: Application to Iron-Sulfur Proteins," *Proceedings of the National Academy of Sciences USA* 97 (2000): 11922.

[15] P. Rüst, "The Unbelievable Belief that Almost any DNA Sequence Will Specify Life," unpublished paper (1988) presented at the Conference on Sources of Information Content in DNA in Tacoma, WA; P. Rüst, "How has Life and its Diversity Been Produced?" *PSCF* 44 (1992): 80. Evolutionary alternatives to random chains of point mutations (such as recombination and other macro-mutations) are much rarer than single-base mutations (cf. A. Rokas & P. W. H. Holland, "Rare Genomic Changes as a Tool for Phylogenetics," *Trends in Ecology and Evolution* 15 [2000]: 454) and hardly produce any new information, as they mostly shuffle pre-existing contents; also, the functional starting sequences would have to originate first.

[16] L. E. Orgel, "The Origin of Life—A Review of Facts and Speculation," *Trends in Biochemical Science* 23 (1998): 491; L. E. Orgel, "Self-organizing Biochemical Cycles," *Proceedings of the National Academy of Sciences USA* 97 (2000): 12503.

[17] H. J. Van Till, "Basil, Augustine, and the Doctrine of Creation's Functional Integrity," *Science & Christian Belief* 8 (1996): 21.

[18] Psalm 104:29–30; Matthew 10:29.

[19] Philippians 2:7; John 1:14.

Natural Hazards: Challenges to the Creation Mandate of Dominion?

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Natural Hazards and Natural Evil

Natural hazards (earthquakes, volcanic eruptions, fire, floods, and storms) are part of the problem of evil, or more particularly, part of the problem of "natural evil." Such potentially destructive events have been understood theologically in a variety of ways. Within the history of Christian reflection on the problem of evil, "natural evil" has been viewed as a consequence of the fall of free moral beings, or as part of the very good creation intended by God.[1] Also important in shaping Christian views on "natural evil" has been the place of the natural world in the eschatological vision.

Paul Santmire traces three prominent metaphors in Christian theology: (1) the metaphor of ascent, (2) the metaphor of fecundity, and (3) the metaphor of migration to a good land.[2] In the first metaphor, humanity is called not only upward toward God but "above and beyond the world of nature, in order to enter into communion or union with God who is thought of as pure spirit."[3] The latter two metaphors form the foundation for a less anthropocentric and more ecological theology in which humanity is redeemed with nature in the formation of a new heavens and a new Earth. Related to these eschatological visions, and equally important in influencing theological reflection on the human relationship to nature, is our understanding of what it means to exercise dominion as beings created in the image of God.[4]

One popularly held view is that hazardous natural events are reflections of the fallenness of the creation. Natural hazards along with other unpleasant or "untamed" aspects of nature are attributed to the consequences of Adam's disobedience. Humanity is thus placed in a position of conflict with fallen nature. The creation mandate of dominion becomes a struggle to control or subjugate the forces of nature. Resonating with common American cultural values, this theological view expresses itself by attempting to defy natural forces through the application of technology.

The view that natural processes are fallen, and not part of God's "very good" creation, however, finds little support in Scripture. Natural events, even destructive ones, are attributed solely to God's purposeful action. Such events are understood in Scripture as expressions of God's creative power that call forth our praise, not as satanic corruptions of a previously placid creation order. The revelation of God's power, holiness, and majesty to his people was often accompanied by manifestations of fire, storm, and earthquake, as at Mt. Sinai during the deliverance of the Law. Furthermore, the historical record of creation itself testifies that such destructive events have always been integral components of the created order. Catastrophic geologic events are recorded throughout Earth's history where they played important roles in the evolution of Earth's landscapes, environments, and biological communities.

Destructive natural events have also commonly been viewed as agents or signs of God's judgment. Scripture certainly views some events in this way. The plagues of the Exodus are one clear example. God can, and does, use such events to affect the course of human events and execute his justice. However, great caution must be exercised in identifying any specific catastrophic event as an act of

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divine judgment. Jesus himself made it clear that it is wrong to assume that the victims of these events are deserving of special judgment (Luke 13:1–5). Furthermore, *all* physical events or processes are under God's providential control and may be used by God to accomplish his purposes in human redemptive history. Although God sometimes uses dramatic natural events to reveal or to carry out his will in human history, this does not make such events "unnatural" or outside the range of physical events God has ordained for the continual renewal of his creation. These events are still a normal and necessary part of his creation. If earthquake, fire, and flood are aspects of God's providential activity in the natural world, then how do we as God's stewards of creation exercise our biblical mandate?

Defining Natural Hazards

Before discussing our response, let us understand in what ways "natural hazards" are natural. First, these events are necessary consequences of the physical forces acting on the Earth.[5] Earthquakes and volcanic eruptions are part of the dynamic processes driven by the release of the Earth's internal heat by which the Earth's crust is continually created and destroyed. Landslides, avalanches, and mud slides are mechanisms by which the weathered materials of the Earth's surface are transported by the forces of gravity eventually to be deposited and become incorporated into the rock cycle. Intense storms, and the flooding rains and high winds they contain, are consequences of atmospheric circulation driven by differences in the amount of solar radiation received and absorbed at the Earth's surface, and by the effects of the Earth's rotation.

Secondly, an examination of both the dynamics of modern ecosystems and the geologic record demonstrates that apparently destructive events are important components of natural systems to which organisms have adapted and on which they are dependent. The characteristics of ecosystems are determined in part by the nature and frequency of physical disturbance. Floods, for example, clear stream beds and banks of fine sediment and maintain critical riverbed and riparian habitats. Flooding rivers also supply nutrient-rich sediment to their floodplains and carry sediment to delta wetlands, preserving them against the effects of subsidence. Similarly, wind and waves from coastal storms are vital parts of the highly dynamic sediment transport systems of coastlines. The ecosystems of these environments adapt to this continual disturbance. Storm waves washing over barrier islands, for example, clear dune vegetation and provide critical new habitat for beach-nesting birds. Also, the intensity and frequency of storm events are major controlling factors in shallow marine ecosystems affecting both species diversity and composition. Fire is increasingly being recognized as an integral part of both grassland and forest ecosystems. Certain plants even require fire to reseed themselves.

Why are natural events such as earthquakes, storms, fire, and flood that are clearly vital parts of the created order considered "hazards"? The obvious answer is that they are "hazardous" in the sense of being threats to human life, property, or other economic interests. These threats are caused by the human development of disturbance-dominated landscapes. Such development is often done either without an awareness of the natural processes characteristic of the area, or in a conscious attempt to defy those processes. Typically, the development of naturally disturbed areas is accompanied by efforts to forcefully control or alter the natural system by the application of technology. This commonly has the unintended consequence of requiring even more technological intervention and increased economic costs. Furthermore, the technologies being applied are often ineffectual and have significant negative impacts on the ecosystems involved.

Dominion as Technological Control

Flood control is one example where the application of technology in many cases has increased the threat of economic loss while degrading the river habitat. When rivers are allowed to occupy their floodplains, flood waters spread out and slow down, thus broadening the flood crest and reducing flood levels downstream. In the process, the fine sediment that is deposited enriches and builds up floodplain

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soils. Confining rivers within artificial levee systems has resulted in both higher river levels and higher flow velocities during floods. When the levees are breached, higher water velocities have more erosive ability and deposit coarse sediments over agricultural land. Flood-control dams also have consequences for river behavior and ecology. Without regular flooding, riparian habitats down river become choked with invasive vegetation and fine sediment accumulates on river beds and banks. The trapping of sediment behind dams reduces the sediment supply to coastal areas resulting in increased shoreline erosion and flooded delta areas. The altered temperatures and oxygen levels of the water impounded behind dams result in the loss of native river species. Many river species, especially mollusks, have become extinct or highly threatened as a result of intensive construction of levees and dams.

A further danger of levee and dam construction is "serial engineering." The false sense of security generated by these structures encourages building on the floodplain. When flooding ultimately occurs, the response is often to build more flood control structures which stimulate yet more development. As a result, more and more human lives and property are placed under threat, and the human and economic loss associated with floods is increased, not decreased. In most cases, the best course of action is to prevent further development of the floodplain, setting aside areas where rivers are free to occupy their floodplains.

The catastrophic flooding of the Midwest in 1993 brought renewed attention to these issues and brought existing floodplain management practices into question.[6] Of particular significance was the extensive governmental report on the '93 floods by the Interagency Floodplain Management Review Committee.[7] This report recognized the failure of primary reliance upon flood protection structures and the vulnerability of floodplain development. As a result of the reevaluation process, government agencies and many local communities have begun to think more seriously about hazard avoidance and floodplain restoration and to embrace a more ecological ethic.[8]

Coastlines provide other examples of dynamic and disturbance-adapted environments that can be developed only with significant alteration to the natural system. These environments also are host to a wide range of ecologically important terrestrial and marine habitats. Barrier islands, in particular, are highly dynamic and mobile landforms. The sand of which they are composed is being continually transported down the coast by wave action. Storms transport beach sediment seaward where it accumulates to form offshore sandbars. These sandbars provide breakwaters for large storm waves. Storms also transport sand over the islands resulting in their gradual landward shift.

Structures designed to protect beachfront property from storm waves interfere with this sediment transport system. Jetties and groins act as sediment dams blocking the shore-parallel transport of sand and starving beaches further down the coast with resulting increases in beach erosion. Seawalls prevent the onshore/offshore movement of sand by which the shoreline adjusts to changes in storm intensity. Pilkey and Dixon have dramatically documented the consequences of these efforts at beach stabilization.[9] The management of beachfront properties frequently becomes another case of serial engineering in which increasing development generates more and more dramatic and costly intervention. Yet, despite these technological interventions, barrier islands remain mobile unstable features, and the threat of significant economic and human loss grows with increasing development.

Fire is another example of a natural disturbance whose attempted elimination has resulted in unexpected, significant negative consequences. Terrestrial ecosystems have evolved within particular regimes of fire intensity and frequency. Many aspects of plant ecology are adapted to, and dependent on periodic burning.[10] In native grassland, fire is a critical factor in maintaining the ecology and productivity of the prairie.[11] The frequency of burning controls the balance of grasses to herbaceous plants and bushes. Fire suppression favors forbs and bushes over grasses, and over time will result in the replacement of the grassland by a scrub woodland. In more arid regions, fire controls the growth of creosote bushes that sap up precious water and inhibit the growth of other plants. In mature conifer forests, fire eliminates undergrowth that chokes out young fire-resistant trees in the understory, and opens the resinous cones of reproducing trees. For these and other reasons, fire is increasingly being used as a management tool for a wide range of terrestrial ecosystems.[12]

The aggressive suppression of fire in both grasslands and forests has also ironically resulted in increased fire hazards. Regularly occurring fires remove built-up thatch or forest litter, controlling the amount of available fuel. When fires are continually suppressed, the amount of available fuel accumulates to dangerous levels resulting in hotter and more extensive burns. The suppression of fire also has encouraged the construction of homes in

areas normally subject to frequent fires, thus requiring even more expensive fire suppression efforts. Firefighters are forced to protect properties located in areas where controlling fires is difficult and where the risk to firefighters is greater. Again, the attempts to defy natural processes have increased rather than decreased the hazards.

A Stewardship Perspective

How can a Christian environmental ethic inform the management of disturbance-dominated environments? One important way is by opposing cultural forces in our society that elevate economic interests and personal desires above creation stewardship and societal responsibilities. Development is often pursued, not only in ignorance of its geological and ecological consequences, but also without regard to the interests of other people. Individual property rights can take precedence over responsibility for the costs of development to both the environment and society. This is exacerbated by a "can do" attitude that sees technological solutions to any potential problem. What often results is escalating spirals of technological intervention and ill-advised development that increase the hazard to human life and property while negatively altering natural habitats. The biblical view of our position as stewards of God's creation should provide a powerful antidote to this perspective. For those who recognize that we cannot claim ultimate ownership of anything, the goal of land management becomes the preservation of that which has been entrusted to us by God. In place of the forceful domination and exploitation of nature, Christians should heed the call to serve and care for that which God created and called "very good." However, this must also be accompanied by a conscious effort to become more aware of our physical and biological environment. We simply cannot exercise proper stewardship armed only with a good theology. We must also become familiar with the creation over which God has made us stewards. Much of our society has become isolated from the natural environment both physically and spiritually. We will continue to be in conflict with our environment as long as we fail to learn from God's creation.

It should be emphasized that the stewardship perspective that I am advocating is not equivalent to a call for the abandonment of an active human role in environmental management. Humans are now an integral component of the world's ecological and geological system. We could not isolate the environment from our influence even if we so desired. Furthermore, the creation mandate of service given to us by God is an active, not a passive one. My appeal is not to abandon technology, but to apply it in appropriate ways that recognize the dynamics and ecological roles of natural disturbance.

Events or processes seen as hazards or obstacles to human activity are vital parts of the created order. They are integral to the continual renewal of the Earth's land and ecosystems—restoring the fertility of soils, maintaining ecosystem diversity, and creating vital habitats for animal and plant species. "Destructive" natural events are not processes to be fought and overcome, but aspects of God's "very good" creation to be understood and accommodated. The exercise of our divine commission to have dominion over creation must be done in humble service, not in power.[13] This mandate requires that we understand the dynamics of the creation over which we have been made stewards. The human suffering and property destruction resulting from natural hazards may indeed be expressions of God's judgment—the consequences of our sinful self-interested use of the environment and our failure to respect those natural processes established by God as agents of creation's renewal. ✳

Notes

[1]J. Hick, *Evil and the God of Love*, rev. ed. (New York: Harper Collins, 1977), 389.

[2]H. P. Santmire, *The Travail of Nature: The Ambiguous Ecological Promise of Christian Theology* (Minneapolis, MN: Fortress Press, 1985), 274.

[3]Ibid., 21.

[4]D. J. Hall, *Imaging God: Dominion as Stewardship* (Grand Rapids: Wm. B. Eerdmans Publishing, Co., 1986) 248.

[5]L. W. Lundgren, *Environmental Geology*, 2d ed. (New York: Prentice Hall, 1999).

[6]D. Snyder, and S. P. Bruner, "The Galloway Report: New floodplain Management or Business as Usual?" *Journal of Soil and Water Conservation* (Nov/Dec 1994): 528–34; and S. A. Changnon, ed., *The Great Flood of 1993: Causes, Impacts, and Responses* (Boulder, CO: Westview Press, 1996), 319.

[7]Interagency Floodplain Management Review Committee (Brigadier General G. E. Galloway, Chair), *Sharing the Challenge: Floodplain Management into the 21st Century* (Washington, DC: U.S. Government Printing Office, 1994).

[8]Snyder and Bruner, "The Galloway Report: New Floodplain Management or Business as Usual?"

[9]O. H. Pilkey and K. L. Dixon, *The Corps and the Shore* (Washington, DC: Island Press, 1996), 272.

[10]W. J. Bond and B. W. van Wilgen, *Fire and Plants* (London: Chapman & Hall, 1996), 263.

[11]O. J. Reichman, *Konza Prairie: A Tallgrass Natural History* (Lawrence, KS: University Press of Kansas, 1987), 226.

[12]L F. DeBano, D. G. Neary, and P. F. Ffolliott, *Fire's Effects on Ecosystems* (New York: John Wiley & Sons, 1998), 333.

[13]This is a point emphasized by Douglas John Hall in *Imaging God*.

From Objective-Realism to Subjective-Relativism: Can We Find a Golden Mean?

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In his Rede Lecture at Cambridge, in May 1959, C. P. Snow describes two wars: one in the late nineteenth century between religion and science, and the other in the second half of the twentieth century between the sciences and humanities.[1] In a recent article in *Science* titled "Deconstructing the Science Wars by Reconstructing an Old Mold," Stephen Jay Gould quotes Snow's article and attempts to find a "*golden mean*," or the *aurea mediocritus* of Horace and Aristotle for the undeclared war between the sciences and the humanities.[2] The former represents all working scientists that generally uphold the objective and progressive nature of scientific knowledge, dubbed "realists," and the latter, all of the humanities and social sciences, where postmodernists regard all claims to truth to be culturally embedded, including science. In fact, the truth claims in science are considered as social constructs with their own conventions and arbitrariness.

It follows immediately from the above that Christianity's truth claims, which are based both on revelation and the use of reason, put the Christians concerned with the relationships between faith and science in the middle of both wars mentioned by Snow: between revealed religion and science on the one hand, and between the sciences and the humanities on the other hand. As we will discuss below, the former has created a new battleground, a standoff between proponents of Intelligent Design on one side, and the Naturalists, on the other side.

The Question

If Christians concerned with the relationships between faith and science agree that all truth is God's truth, and that all knowledge—whether it be socially constructed, empirically determined, or experienced through divine revelation—comes from God, could we find a *golden mean* that does justice to all three modes of knowledge, without hopelessly compromising the validity of any one of them? To answer this question correctly, we, as with Gould, first have to take a hard look at the alleged dichotomy between objective realism and subjective relativism, and then add the element of divine revelation into the equation. But unlike Gould, we find the *golden mean* through apologetics.

Objectivity and Subjectivity in Human Knowledge

The polarization between objective-realism and subjective-relativism created by social constructivists represents a false dichotomy based on a misunderstanding of scientific truth claims. This misunderstanding has arisen from a misrepresentation of what science actually entails. It is an objectivist myth that science is based on a fully general method, rooted in observation and experimentation, by minds consciously free of bias, using universal tools of reason to accumulate reliable knowledge, steadily and inexorably. In fact, as with all human activities, science is and always will remain part of human culture. Despite their best efforts to remain objective, scientists are human, subject to emotional and even irrational vagaries, and reluctant to give up cherished and established theories even in view of anomalies that question their accepted norms.[3] A classic example is the manner in which Wegener was ostracized and ridiculed by colleagues for his theory of tectonic plates in 1915.[4] Wegener supported his work with extensive geological research

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but died in 1930 as an intellectual outcast. Now, almost seventy years after his death, his idea is accepted as common wisdom.

Rescher Approach: What is Objectivity

I believe the first step toward removing this false dichotomy is to revisit the correct definition for objectivity best articulated by Nicholas Rescher in his book *Objectivity: The Obligation of Impersonal Reason*. Rescher says that the present and more relevant mode of "objectivity" relates

> ... to the appropriateness of claims or contentions, addressing the question of whether a claim is impersonally and generically cogent rather than personal and idiosyncratic – whether it holds not just for me (egocentric subjectivity) or for some of us (parochial subjectivity) but for all of us (impersonal or interpersonal objectivity). It is this *epistemic* mode of objectivity that primarily concerns us here. Objectivity in this sense has to do not with the *subject matter* of a claim but with its *justification*.[5]

Such objectivity calls for seeking to eliminate the distorting influence of personal or parochial eccentricities. It is not at odds with having particular commitments, and in fact, accepts contextuality (the *sine qua non* of social constructionists) as an objective fact. In the last chapter entitled "Is Objectivity Subject to Limits?" Rescher demonstrates that the very fact that we all have a "private space" in life where subjectivity reigns supreme, is itself an *objective fact* about our condition, as best rational inquiry reveals to us.[6] Finally, Rescher concludes:

> Intelligence does not stand as one limited faculty over against others (emotion, affection, and the like). It is an all-pervasive light that can shine through to every endeavor, even those in which reason herself is not involved. Whatever human undertaking is valid and appropriate can be shown to be sound by the use of reason. It is the exercise of objectivizing rationality that informs us about priorities.[7]

The Polanyi Approach: Personal Knowledge

Michael Polanyi in his monumental work titled *Personal Knowledge Towards a Post-Critical Philosophy* tackles the issue of objectivity in the framework of *personal knowledge*.[8] The latter is manifested in the physical sciences, and is seen to work even more extensively in the social/behavioral sciences. In both disciplines, the act of knowing, according to Polanyi, includes an evaluation – a personal dimension that bridges the disjunction between subjectivity and objectivity, bringing fact and value, and science and humanity back together. Polanyi demonstrates that the scientist's personal participation in the discovery and validation is an indispensable part of science itself. Even in the physical sciences, "knowing" is ultimately an art where the skill of the knower guided by personal commitment will put him or her in contact with reality. All this becomes even more evident in the biological and behavioral sciences. All in all, there is neither a reality entirely independent of human inquiry nor a perspective without some influence from the world.

A good example of Rescher's and Polanyi's analyses is an honest evaluation made by anthropologist David Lewis. Lewis contends that anthropologists strive for objectivity, but rarely, if ever, can break free from the fetters of subjectivity.[9] Increasingly, scientists are recognizing that the anthropologist's own background, theoretical bias, and experience of field work can channel his or her thinking along lines that affect the conclusion reached. In fact, in Lewis' own study of religious awareness in Russia and Central Asia, he claims that a religious faith in the researcher can actually be an advantage rather than a disadvantage.

The Cultural Continuum

With these insights into objectivity, we can now reconstruct the cultural continuum of H. G. Cassidy (Figure 1) where all disciplines are peripherally and radially related and where metaphysical, philosophical, and theological frameworks provide a world view for the various disciplines.[10] These disciplines cover the full spectrum of academic activities, circumscribing the exact and inexact sciences, the reasoned and the revealed, the objective and the subjective, the quantitative and the qualitative; each approach representing an incomplete *but* essential aspect of human activity. What we then look for is

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an *aggregate* of these endeavors, woven together as individual strands, into a coherent whole. One way for the Christian to do this, is to look for the *golden mean* through apologetics.

The Five Strands of Evidence

For Christians concerned with the relationship between faith and science, the centrality of religion, specifically in the form of Christian truth claims, gives a coherent view of reality. To justify our contention, we resort to the analogy of the weaving together of a multiplicity of strands where each strand represents an aspect of reality, necessary for grasping truth, but sufficient only when all the strands are taken together as a whole.[12] To this end, a Christian apologist can identify *five strands* of evidences, each of which is *necessary* but not *sufficient*, unless woven together into a rope of multiple strands that can withstand attacks from any source, be it from the ontological naturalist, the cultural constructionist, or the religious extremist. The multiple strand approach will provide the only satisfactory answer for resolving the dichotomy between the objective and the subjective, faith and reason. One way to represent these five strands is as follows:[13] (1) evidences from the physical universe; (2) evidences from human nature; (3) evidences from history and archaeology; (4) evidences from Scriptures, and (5) evidences from self (or intuitive) knowledge, where the individual contacts the Creator in the innermost parts of his or her being. For the sake of completeness, let me briefly explain the scope of each evidence.

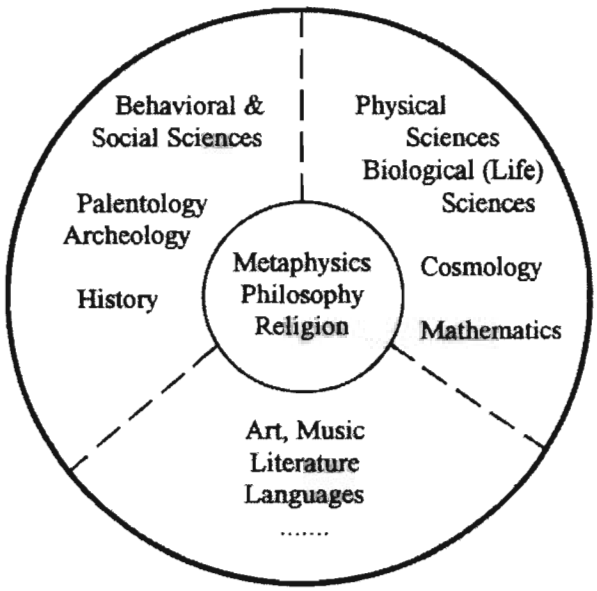

Figure 1. The Cultural Continuum.

1. Evidences from the Physical World

The renewed emphasis on Intelligent Design has brought into focus several evidences from nature that have become the favored apologetic tools for some Christians, but targets of attack by ontological naturalists. Among the more compelling evidences are: (a) the problem of origins (universe and life); (b) the fine-tuned universe;[14] (c) specified complexity and irreducible complexity;[15] (d) Goedels' theorem of incompleteness applied to mathematics *and* information theory;[16] and (e) the unreasonable effectiveness of mathematics at modeling the physical world.

Each evidence has shed some new light on the possibility of finding empirical evidence for intelligent design in nature, which Hugh Ross calls the "fingerprint of God" after the manner of Psalm 8:3. However, it should be noted that the counter-attack from naturalists has been strong, pervasive, and often effective.[17] Though these evidences collectively represent an important strand of evidence for a Creator and strengthen the faith of the believer, they often leave the committed naturalist unimpressed. A question often asked by the ontological naturalist as he challenges the ID advocates is, "How would science be done differently if one accepts design?" I believe that an appropriate answer would be that of Nobel Laureate I. I. Rabi, a conservative Jew. One of his oft quoted statements goes as follows:

> Physics filled me with awe, put me in touch with a sense of original causes. Physics brought me closer to God. That feeling stayed with me throughout my years in science. Whenever one of my students came to me with a scientific project, I asked only one question, "Will it bring you nearer to God?"[18]

Here, Rabi does not stop at the empirical evidence of an Intelligent Designer, but by identifying the Intelligent Designer as the Creator, it leads him to experience the unity between the way he can know God and do his scientific work.

2. Nature of Human Existence

The issues here are the fact of human existence, the meaning of life, the complexity of self, human consciousness, the moral universe, man's innate sense of the nouminal, among others. One key unresolved question today is whether human consciousness will ever be explained from a purely naturalistic approach. Penrose, for example, argues for a new physics that would approach the study of consciousness from a yet unknown angle such as quantum mechanical wave function coherence. At present, consciousness transcends computation.[19]

In a recent book, psychologist Jerome Kagan from Harvard breaks rank with conventional analysts and presents empirical evidence that humans are: (a) free and willful enough to do things for reasons; (b) self-conscious enough to appreciate the significance of experiences; (c) aware of long-term consequences of action, and (d) spiritual enough to be motivated to be good (not just maximize pleasure and minimize pain, according to the wisdom of evolutionary psychology).[20] Although the claims of Penrose and Kagan have been strongly debated, nevertheless humans understand things in a way that no computer ever will.

The hierarchy of knowledge in understanding reality, the so-called supervenience theory, a bottom-up structure considered by some IDers as being reductionist, is another approach that demonstrates that the whole is always more than the sum of its parts.[21] The tremendous complexity inherent in the nature of human existence presents a real challenge to the naturalist, and thus represents the second strand of evidence.

3. Evidences from History and Archaeology

If the evidences from nature point to God's fingerprint, history points to his footsteps. After all, if God created man in space and time, it is only logical that he should interact with human affairs in history. Can his footsteps be heard in human history? Here the Christian apologist raises many intriguing questions where purely naturalistic answers are inadequate. For example, religion has been found to be persistent and universal throughout human history. Every known civilization has developed religious beliefs as a key component of their culture. The longest lasting and large-scale experiment in atheism practiced by the Soviet Union and Eastern Europe was a dismal failure. After seventy years of brutal suppression, religion survived and has now become a dominant force in every country previously under the hegemony of the Soviet Union. *Could it be that reality is spiritual in origin rather than material?* Or how does one explain in purely naturalistic terms the disappearance of powerful empires and civilizations (Babylonian, Egyptian, Roman) and the persistence of a tiny nation Israel and the Jewish culture persecuted relentlessly over millennia? Like the proverbial phoenix, the nation rises from its ashes after being defunct for over 1800 years. Finally, an obscure Semitic cult called "Christianity" expands rapidly. It defeats not only a dozen well-entrenched and powerful rival cults, but the whole Roman Empire within four centuries, without raising a sword.[22] If such a rapid growth implies "divine nurture" and one accepts the validity of the abductive approach, it would be disingenuous not to consider the bodily resurrection of Christ that fueled such rapid growth as inference to the best explanation. In fact, if one considers *all* the data on hand—such as the empty tomb, the integrity of the followers of Christ willing to die for their cause, the hostile atmosphere in which the Good News prevailed—the best explanation is that indeed Jesus rose bodily from the dead.

4. Evidence from Scripture.

The arguments here are centered around the historical reliability of Scripture, its internal self-consistency, its view of nature as being contingent, created by a transcendent God, its prophetic fulfillments, and its moral imperatives set realistically within the context of an imperfect world. All of the above set the Bible apart from other competing belief systems. No other religious book exposes itself to scrutiny by historians and archaeologists, who can employ extrabiblical information to verify or refute the countless references the Bible makes to historical dates, characters, and geographic locations.[23]

If evidence (3) above represents God's footsteps in history, then evidence (4) is his written Word—the very logos that has brought into existence all matter, energy, and information and has made the world intelligible. The logos expresses speech, inward thoughts, life, light, and eventually, the materialization of all that which is intangible and inaccessible to the senses; the incarnation of the Creator in the form of his Son, Jesus Christ. The logos blends the natural and supernatural into a single reality with multiple aspects that can provide the only satisfactory answers to nature's profound mysteries.

5. Evidence from Self-Knowledge.

If the previous four evidences engage the mind, the fifth evidence reflects the statement made by Blaise Pascal: "The heart has its reasons the mind will never know." It leads to self-evident knowledge which can become compellingly certain without being inferred from any other knowledge. Roy Clouser uses the traditional term "intuition" for such noninferrential recognition of truth.[24] Such truth is apprehended directly, nondiscursively as one reflectively compares it to one's present and past experiences of self-evident beliefs.[25]

Many, if not most scientific insights, have come through the "a ha" of intuition. One of the best known flashes of insight is provided by Henri Poincare. He describes how he had intensive periods of deliberate and conscious search for what he called Fuchsian functions, but had reached an impasse. He left for a geologic excursion, forgetting

his mathematical work. As he stepped into a bus, the solution came to him in a flash. He says: "Without anything in my former thoughts seemingly to have paved the way for it ..." —full comprehension in a single moment!

For the Christian, of course, this intuitive insight can move a step higher and come from the Holy Spirit. The truth of the Incarnation is revealed into a person's innermost being where the knowledge *about* God leads to a personal encounter *with* the living God: a subjective experience that has its objective correlate for many to see.

If evidences (1) and (2) reveal God's fingerprint, evidence (3) his footsteps, evidence (4) his written Word, then evidence (5) reveals his heartbeat! Each evidence is *necessary*, but in itself is *insufficient*. Taken *together* however, all conditions are fulfilled.

It should be noted that the five strands described above cover the entire spectrum of human knowledge, from objective-realism to subjective-relativism (personal experience may be a more appropriate choice of word than relativism). An alternate representation of these five strands and the mutual support they offer, is an equilateral triangle, where the three sides represent one (or more) of these strands (Figure 2), each side touching the other two (which means that each evidence is *linked* to the other four), forming a rigid geometric structure, one that can withstand best, the arrows of the ontological naturalist's counter attack. A better illustration would be to bisect the triangle into three contiguous, equilateral triangles, each representing one or two strands of evidence.

The Five "Alls"

There is one more factor for the Christian apologist that provides the ultimate unifying force which brings all knowledge together, and that is the person of Jesus Christ. Unlike any other religious leader, past or present, the New Testament records at least five "alls" that speak of the sweeping claims that all creation is under Christ's authority, and continuously infused and upheld by the "power of his word."

1. Then Jesus came to them and said, "*All* authority in heaven and on earth has been given to me" (Matthew 28:18).
2. *All* things were made by him; and without him was not anything made that was made (John 1:3).
3. And God placed *all* things under his feet and appointed him to be head over everything for the church (Ephesians 1:22).
4. He is the image of the invisible God, the first born over *all* creation (Colossians 1:15; 2:9).
5. The Son is the radiance of God's glory and the exact representation of his being, sustaining *all* things by his powerful word (Hebrews 1:3).

The centrality of Christ in all human affairs can be best illustrated through a diagrammatic representation of the nature of a person (Figure 3). The outermost ring represents the physical aspect of a human, which is in touch with the physical world through the five senses. The inner circle represents a person's intellect, emotions, and will, which constitutes the *soul*. These three are distinct faculties of an individual but are contiguous, merging to form a

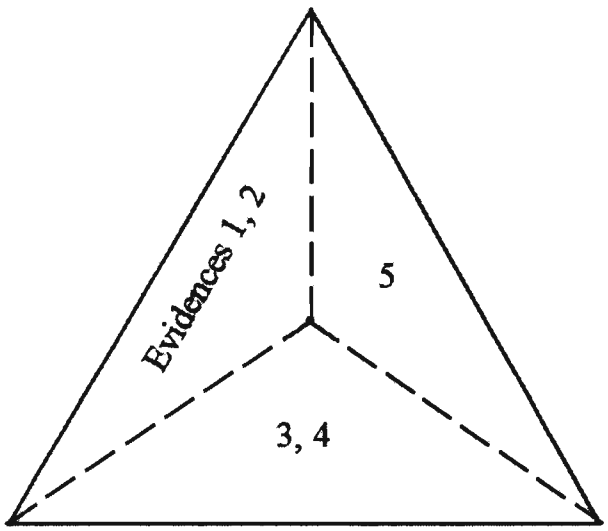

Figure 2. The Triangle of Evidences.

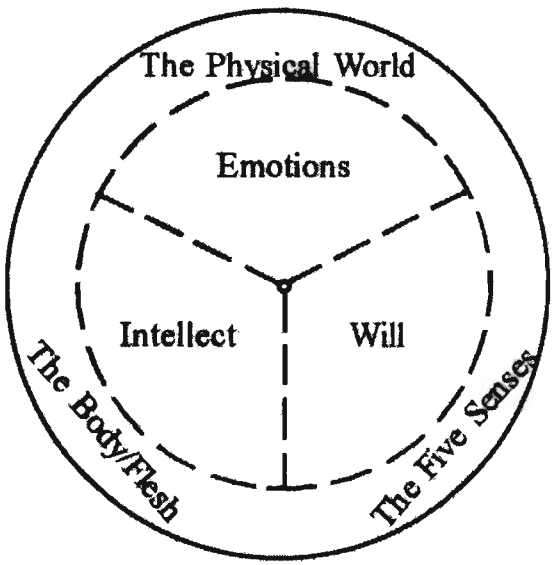

Figure 3. The Body-Soul-Spirit Continuum.

whole, as shown by the dotted lines. The three lines intersect at a point which can represent the seat of the conscience, or the *spirit* of a person, where God's Spirit intersects the human spirit from *above (a higher dimension)*. A point has no dimension, no substance. It only exists as lines intersect each other. The point then becomes the immaterial, intangible aspect in humans, where the intellect, emotions, and the will meet, yielding the *imago Dei* imprint—the place where the Lordship of Christ enters the individual, through the Holy Spirit, and sustains his or her very being.

Concluding Remarks

The biblical, social, and historical analyses of science pose no threat to the core assumption of the scientific endeavor, that a *real world* exists out there which can be understood and explained. These analyses can aid the institution of science by revealing science as an accessible form of human creativity, not just some exotic activity open only to a hallowed few.

It is evident from the above arguments that indeed we can find an *aurea mediocritus* if we can break through the emotions of mutual anathema of the two poles of the objective/quantitative and the subjective/qualitative, and move toward literal mediation.[26] Both objective realism and the subjective experiential dimension are essential elements for the proper defense of Christian truth claims. The additional component that the Judeo-Christian tradition brings to all existence is the divine revelation (where the "natural" analogue is human intuition). It too can be understood through the proper balance between the objective/quantitative and the subjective/qualitative. The Apostle John states this succinctly: "But these are *written* that you may believe ..." (John 20:30) and "That which was from the beginning which we have *heard*, which we have *seen* with our eyes, which we have *looked at* and our hands have *touched*" (1 John 1:1). Thus for the Christian, the tangible, the objective, the measurable, meet the subjective, the personal, the nouminous to form a unified whole where Christ the Logos blends the natural and the supernatural into a single reality.[27]

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Acknowledgment

The author expresses his appreciation to the two reviewers for their valuable comments and insights, all of which have been incorporated in the revised manuscript.

Notes

[1]C. P. Snow, see Stephen J. Gould, *Science* 287, no. 5451 (14 Jan 2000): 61, see notes.
[2]Ibid., 254–5.
[3]Thomas Kuhn, *The Structure of Scientific Revolutions*, 2d ed. enlarged (Chicago: Chicago Univ., 1970).
[4]"Science Beyond the Pale," *Science* 249 (6 July 1990): 14–6.
[5]Nicholas Rescher, *Objectivity: The Obligation of Impersonal Reason* (Notre Dame, IN: Univ. of Notre Dame Press, 1997), 4.
[6]Ibid., 210.
[7]Ibid., 212.
[8]Michael Polanyi, *Personal Knowledge Towards a Post-Critical Philosophy* (Chicago: Univ. of Chicago, 1962), 17.
[9]David C. Lewis, *After Atheism: Religion & Ethnicity in Russia and Central Asia* (Curazon: Caucasus World, 2000), 14–20.
[10]H. G. Cassidy, *The Science & the Arts* (New York: Harper Brothers, 1962).
[11]W. W. Watts, *Journal of the ASA* (September 1973): 91.
[12]N. David Nermin, "What's Wrong with this Sustaining Myth?" *Physics Today* (March 1996): 11–3; and K. J. Touryan, "Are Truth Claims in Science Socially Constructed?" *Perspectives on Science and Christian Faith* 51, no. 2 (June 1999): 102–7.
[13]These do not represent an exhaustive set.
[14]Peter D. Ward & Donald Brownlee, *Rare Earth* (Copernicus Springer-Verlag, 2000).
[15]William A. Dembski, *Intelligent Design* (Downers Grove, IL: IV Press, 1999).
[16]Gregory J. Chaitin, "Gödel's Theorem & Information," *International Journal of Theoretical Physics* 21, no. 12 (1982): 941–53.
[17]The Nature of Nature Conference held at the Polanyi Center, Baylor University, April 12–15, 2000 in Waco, TX.
[18]*Physics Today* (Sept. 1999): 38.
[19]R. P. Penrose, *Shadows of the Mind: A Search for the Missing Science of Consciousness* (Oxford: Oxford University Press, 1996).
[20]Jerome Kagan, *Three Seductive Ideas* (Cambridge, MA: Harvard University Press, 1989), 189–93.
[21]See, for example, Paul Teller, "A Poor Man's Guide to Supervenience and Determination," *So. Journal of Philosophy* 22, Supplement (1984): 137–62.
[22]Herschel Baker, *The Image of Man* (New York: Harper Torch Books, 1947), 124.
[23]See, for example, Edwin Yamauchi, *The Stones and the Scriptures* (Philadelphia & New York: Holman Book, 1972).
[24]Roy Clouser, *Knowing with the Heart* (Downers Grove, IL: IV Press, 1999), 72.
[25]Clouser gives an impressive list of thinkers who have described such non-discursive experiences: Aristotle, Aquinas, Descartes, John Locke, Leibnitz, Popper, Platinga, (p. 185, ref. 22). Platinga, for example, affirms belief in God from direct perception (see *Faith & Rationality* (Notre Dame, IN: University of Notre Dame Press, 1983).
[26]See Stephen J. Gould, *Science* 287, no. 5451 (14 Jan 2000): 254–5; and C. S. Peirce, *Collected Papers of Charles Sanders Peirce* (Cambridge: Harvard University Press, 1960), see also Chong Ho Yu, "Logic of Abduction," a paper presented at the Annual Meeting of American Educational Research Association, New Orleans, LA, April 1994 (YuHo@aol.com). To understand the nature of knowledge

and reality, whether objective, subjective, reasoned or revealed, the logical system introduced by Charles Sanders Peirce, and discussed by Chong Ho Yu, concerning abduction, deduction, and induction could be helpful here. Abduction and deduction contribute to our conceptual understanding of a phenomenon, while the logic of induction adds quantitative details to the conceptual knowledge. Yu states:

> At the stage of abduction, the goal is to explore the data, find out a pattern, and suggest a plausible hypothesis with the use of proper categories; deduction is to build a logical and testable hypothesis based upon other plausible premises; and induction is the approximation towards the truth in order to fix our beliefs for further inquiry. In short, abduction creates, deduction explicates, and induction verifies.

Humans use all three approaches to gain knowledge in their endeavor to understand and explain the real world, with induction and deduction being the *primary* tools of science, and deduction and abduction often employed by the humanities.

[27]The dotted lines are drawn intentionally to side-step the knotty issues regarding dichotomy or trichotomy. Also, the point where the three triangles, or the five evidences meet, could represent the *entry point where God, through the power of his Word, upholds all of reality, without contravening his physical laws.*

Books Received and Available for Review

This is a partial list of the books available for review. Please contact the book review editor if you would like to review one of them or receive a copy of the complete list. Richard Ruble, Book Review Editor, *Perspectives on Science and Christian Faith*, 212 Western Hills Drive, Siloam Springs, AR 72761. richard@tcainternet.com

John Ashton, ed., *In Six Days: Why 50 Scientists Choose to Believe in Creation*, Master Books, 360 pages, 2001

Connie Barlow, *The Ghosts of Evolution: Nonsensical Fruit, Missing Partners, and Other Ecological Anachronisms*, Basic Books, 220 pages, 2001

Robert Fischer, *Who Is God? Integrating Faith and Learning to Address this Question*, 1st Books Library, 170 pages, 2000

Norman Geisler and Paul Hoffman, eds., *Why I Am a Christian: Leading Thinkers Explain Why They Believe*, Baker Books, 315 pages, 2001

Mary Gerhart & Allan Russell, *New Maps for Old Explorations in Science and Religion*, Continuum, 232 pages, 2001

J. A. Hobson & J. A. Leonard, *Out of its Mind: Psychiatry in Crisis*, Perseus Publishing, 290 pages, 2001

Russell Howell & James Bradley, *Mathematics in a Postmodern Age: A Christian Perspective*, Eerdmans, 400 pages, 2001

James E. Huchingson, *Pandemonium Tremendum: Chaos and Mystery in the Life of God*, The Pilgrim Press, 230 pages, 2001

Vladimir Jankovic, *Reading the Skies: A Cultural History of English Weather 1650–1820*, Chicago University Press, 286 pages, 2001

Edward Larson, *Evolution's Workshop: God and Science on the Galapagos Islands*, Basic Books, 319 pages, 2001

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Charles Darwin and Asa Gray Discuss Teleology and Design

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If Thomas Huxley earned the title of "Darwin's bulldog," then Asa Gray should be remembered as "Darwin's dove." Whereas Huxley enjoyed a good fight in his defense of Darwin's theory, Gray sought to mediate and bring sides together around a common understanding of "good science." As Darwin's strongest and most vocal scientific ally in the United States, Gray recognized the scientific importance of Darwin's efforts for the growing professionalism of biological researchers. But as an orthodox Christian, a Presbyterian firmly devoted to the faith expressed in the Nicene Creed, he saw in Darwin's theory both evidence for his philosophical commitment to natural theology and support for his opposition to the idealism advocated by Louis Agassiz and the *naturphilosophers* in both Europe and America. Indeed, Agassiz's advocacy of Platonic forms as a basis of biological understanding (e.g., "A species is a thought of the creator"[1]) would be a major source of American opposition to Darwin's theory.

Professor of botany at Harvard during most of the middle half of the nineteenth century, Gray was one of the few members of the scientific community to whom Darwin revealed his theory before the publication of *On the Origin of Species*, and, from what I can tell, the only American. Gray and Darwin met briefly in January 1839 during one of Gray's visits to England. Later, during the 1850s, Darwin wrote Gray on several occasions requesting information—a practice that Darwin frequently employed. In 1854, Darwin's friend and confidant, Joseph Hooker, showed Darwin Gray's review of Hooker's *Flora of New Zealand*, in which Gray had argued strongly against Louis Agassiz's idealism and had raised questions from his own work on the stability of species. Gray was not yet ready to deny their permanence, but hybrids and other observations were beginning to trouble him.

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The next year Gray wrote a lucid and penetrating positive evaluation of Alphonse De Candolle's two-volume *Géographie botanique raisonnée*, a pioneering work dealing with plant geography and distribution from a statistical perspective. Hooker had sneeringly dismissed the work. In A. Hunter Dupree's authoritative biography of Gray, he describes Gray's puzzlement at Hooker's response in these terms:

> Although in the long view Gray's evaluation of the epoch-making nature of De Candolle's book was more justified than Hooker's sneers, [Gray was confused by his response, for] Hooker seemed to be talking with a more comprehensive theory definitely in mind, some reason for taking his position, which he did not divulge and which his friend [Gray] did not possess.[2]

Darwin, however, saw in both Gray's review of Hooker's book and in his comments on De Candolle's tome that Gray was troubled by some of the same empirical data that had been bothering him. In April 1855, Darwin wrote Gray to urge that Gray update his *Manual of the Botany of the Northern United States* first published in 1848, and especially to address the issue of the range of Alpine plants in the United States. Specifically, he said: "Now I would say it is your duty to generalise as far as you safely can from your as yet completed work."[3] Behind this request was Darwin's desire to test his impression that Gray could make a good ally. Gray passed the test, and finally, in July 1857, Darwin let Gray in on his theory of the transmutation of species. Gray was never an uncritical supporter, and there are many evidences in the correspondence between these two scientists that Gray was willing to challenge Darwin and disagree with some of his conclusions. Nevertheless, Gray saw the importance of Darwin's work and the ways in which it provided answers to the troublesome issues that he had confronted in his own botanical efforts.

After considerable interchange—one might even say debate—among Gray, Darwin, and Hooker, Gray wrote to Hooker in October 1859 (one month before the publication of *On the Origin of Species*) saying that he had absolutely no problem with cognate species arising by variation. He did, however, raise a concern that would be the source of much future discussion. He wondered about Darwin's "carry[ing] out this view to its ultimate and legitimate results,—how [do] you connect the philosophy of religion with the philosophy of your science." He added: "I should feel uneasy if I could not connect them into a consistent whole—i.e., fundamental principles of science should not be in conflict."[4]

When *Origins* was published, Gray wrote a clear, positive, yet critical review in *The American Journal of Science*. Aware of mounting religious opposition, he ended his review by arguing that whereas one could use Darwin's theory in support of an atheistic view of Nature, one could use any scientific theory in that way. He wrote: "The theory of gravitation and ... the nebular hypothesis assume a *universal and ultimate* physical cause, from which the effects in nature must necessarily have resulted."[5] He did not see the physicists and astronomers who adopted Newton's theories as atheists or pantheists, though Leibnitz earlier had raised such reservations. And a similar situation existed with the origin of species by natural selection. Darwin, Gray continued: "merely takes up a *particular, proximate cause*, or set of such causes, from which, it is argued, the present diversity of species has or may have *contingently* resulted. The author does not say *necessarily* resulted."[6] This far Gray could go with Darwin. But there was a point at which he parted company, and that was the fortuitous randomness of the process that Darwin's theory seemed to imply.

As all good historians of science and of Christian thought know, evangelical Christians in the nineteenth century were generally not biblical literalists, nor did they believe in a young earth. In other words, the religious opposition to Darwin did not arise from perceived problems between Darwin's theory and a literal reading of Genesis. Rather, following the publication of *Origin of Species*, it centered on what seemed to be the randomness of natural selection, the appearance of new organisms by chance, and therefore the exclusion of divine purpose or design in Nature.[7] It was the teleological question that Gray addressed in his review and about which he and Darwin corresponded over many years.

Darwin's response to Gray's review, a copy of which he received prior to its publication, was very positive. Darwin even hoped that it could become a preface in a second American edition of *On the Origin of Species* on which Gray worked. In a letter later in the year to James Dwight Dana, Darwin said: "No one person understands my views & has defended them so well as A. Gray;—though he does not by any means go all the way with me."[8] The "all the way" included teleology, and Darwin wrote this to Gray concerning his attempt to retain design:

> It has always seemed to me that for an Omnipotent & Omniscient Creator to foresee is the same as to preordain; but then when I come to think over this I get into an uncomfortable puzzle *something* analogous with "necessity & Free-will" or the "Origin of evil," or other subject quite beyond the scope of the human intellect.[9]

Three months later he picked up the discussion with these comments:

> With respect to the theological view of the question; this is always painful to me.—I am bewildered.—I had no intention to write atheistically. But I own that I cannot see, as plainly as others do, & as I sh[d] wish to do, evidence of design & beneficence on all sides of us. There seems to me too much misery in the world. I cannot persuade myself that a beneficent & omnipotent God would have designedly created the Ichneumonidae with the express intention of their feeding within the living bodies of caterpillars, or that a cat should play with mice. Not believing this, I see no necessity in the belief that the eye was expressly designed. On the other hand I cannot anyhow be contented to view this wonderful universe & especially the nature of man, & to conclude that everything is the result of brute force. I am inclined to look at everything as resulting from designed laws, with the details, whether good or bad, left to the working out of what we may call chance. Not that this notion *at all* satisfies me .... But the more I think the more bewildered I become; as indeed I have probably shown by this letter.[10]

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Shortly after this letter to Gray, Darwin wrote Charles Lyell on the same subject and said:

> I have said that nat. Selection is to the structure of organised beings, what the human architect is to a building. The very existence of the human architect shows the existence of more general laws; but no one in giving credit for a building to the human architect, thinks it necessary to refer to the laws by which man has appeared. No astronomer in showing how movements of Planets are due to gravity, thinks it necessary to say that the law of gravity was designed that the planets sh[d] pursue the courses which they pursue.—I cannot believe that there is a bit more interference by the Creator in the construction of each species, than in the course of the planets.—It is only owing to Paley & Co, as I believe, that this more special interference is thought necessary with living bodies.[11]

In mentioning "Paley & Co," Darwin was referring to William Paley and other natural theologians, who had argued that nature—through the organization and adaptations of living organisms—demonstrated the existence of an intelligent creator. Darwin had studied Paley while in university, and Gray had also been influenced by the work of Paley, whose eighteenth-century opus *Natural Theology* was an important component of nineteenth-century American philosophy and was still used as a text at Harvard when Gray began teaching there in 1842. Paley's Argument from Design ultimately boiled down to this:

Premise 1: God's will is for us to be happy in this life and the next.

Premise 2: We can discover God's will either by consulting Scripture or by consulting "the light of nature." Both ways will lead to the same conclusion.

Premise 3: The will of God with regard to any action can be found by inquiring into its "tendency to promote or diminish the general happiness."

Conclusion 1: God creates to promote the general happiness of all creatures.

Conclusion 2: Organisms are perfectly adapted to their environment by the Creator.

The corollary of this last conclusion was that perfect design, from the structure and functioning of an organ to the structure of the universe, is evidence for God.

For Paley, Nature provided the evidence for the existence of God, but Darwin had difficulty with this argument. His difficulty centered on what might best be referred to as issues surrounding theodicy, i.e., are natural selection and its results consistent with design by a benevolent God or do they imply that, if designed, God is capable of malevolent intent. In a July 3, 1860, letter to Gray, Darwin explicitly raises the issue. He writes:

> One word more on "designed laws" & "undesigned results." I see a bird which I want for food, take my gun & kill it, I do this *designedly*.—An innocent & good man stands under tree & is killed by flash of lightning. Do you believe (& I really sh[d] like to hear) that God *designedly* killed this man? Many or most person do believe this; I can't & don't.—If you believe so, do you believe that when a swallow snaps up a gnat that God designed that that particular swallow sh[d] snap up that particular gnat at that particular instant? I believe that the man & the gnat are in same predicament.—If the death of neither man or gnat are designed, I see no good reason to believe that their *first* birth or production sh[d] be necessarily designed. Yet, as I said before, I cannot persuade myself that electricity acts, that the tree grows, that man aspires to loftiest conceptions all from blind, brute force.[12]

What Darwin wanted was Design without suffering, teleology without agony, purpose without pain.

This issue becomes the focus of discussion following the third article of a series that Gray published in *The Atlantic Monthly* in July, August, and October of 1860. When these articles were reprinted as a chapter in Gray's *Darwiniana*, the chapter was titled "Natural Selection not Inconsistent with Natural Theology." The passage that focused the discussion for Darwin was this: "We should advise Mr. Darwin to assume, in the philosophy of his hypothesis, that variation has been led along certain beneficial lines."[13]

After stating that the article was "admirable," Darwin responded to Gray in these words:

> But I grieve to say that I cannot honestly go as far as you do about Design .... [Y]ou lead me to infer that you believe "that variation has been led along certain beneficial lines."—I cannot believe this; & I think you would have to believe, that the tail of the fan-tail was led to vary in the number & direction of its feathers in order to gratify the caprice of a few men.[14]

In September, Darwin responded to a question from Gray and informed him of his correspondence with Lyell on the subject of Design. In a lengthy passage, he wrote:

> Your question of what would convince me of Design is a poser. If I saw an angel come down to teach us

> good, & I was convinced, from others seeing him, that I was not mad, I sh[d] believe in design. If I could be convinced thoroughly that life & mind was in an unknown way a function of other imponderable forces, I sh[d] be convinced .... I have lately been corresponding with Lyell, who, I think, adopts your idea of the stream of variation having been led or designed. I have asked him (& he says he will hereafter reflect & answer me) whether he believes that the shape of my nose was designed. If he does, I have nothing more to say. If not, seeing what Fanciers have done by selecting individual differences in the nasal bones of Pigeons, I must think that it is illogical to suppose that the variations, which Nat. Selection preserves for the good of any being, have been designed. But I know that I am in the same sort of muddle (as I have said before) as all the world seems to be in with respect to free will, yet with every supposed to have been foreseen or preordained.[15]

Finally, in December, Darwin sent up the white flag, conceding that "[i]f anything is designed, certainly Man must be; one's 'inner consciousness' (though a false guide) tells one so; yet I cannot admit that man's rudimentary mammae ... & pug-nose were designed .... I am in thick mud;—the orthodox would say in fetid abominable mud."[16] From this point on, the topic is not as central in their correspondence.

Following the publication of Darwin's book on orchids, however, he asked Gray to look at the last chapter, since Darwin believed that it bore on the design question. Gray's response was found in both his review of the book and in a letter to Darwin. In his review, he praised Darwin for having "brought back teleological considerations into botany." He concluded:

> We *faithfully* believe that both natural science and natural theology will richly gain, and equally gain, whether we view each varied form as original, or whether we come to conclude, with Mr. Darwin, that they are derived:—the grand and most important inference of *design in nature* being drawn from the same data, subject to similar difficulties, and enforced by nearly the same considerations, in the one case as in the other.[17]

Gray may have believed that Darwin "brought back teleological considerations into botany," and Darwin may have swung that way in his book on orchids, but by 1867 Darwin had definitely swung back to the other side. In his concluding remarks for *The Variation of Animals and Plants Under Domestication*, he wrote:

> However much we may wish it, we can hardly follow Professor Asa Gray in his belief that "variation has been led along certain beneficial lines," like a stream "along definite and useful lines of irrigation." If we assume that each particular variation was from the beginning of all time preordained, then that plasticity of organisation, which leads to many injurious deviations of structure, as well as the redundant power of reproduction which inevitably leads to a struggle for existence, and, as a consequence, to the natural selection or survival of the fittest, must appear to us superfluous laws of nature. On the other hand, an omnipotent and omniscient Creator ordains everything and foresees everything. Thus we are brought face to face with a difficulty as insoluble as is that of free will and predestination.[18]

An "Insoluble" Question for Darwin

Imbedded in this refusal to follow Gray is the question of theodicy to which I referred earlier. How could an omniscient, omnipotent, *benevolent* God set up a process that led to "injurious deviations of structure"? How could such a Being design a struggle for existence, a survival of the fittest—war for all and death for some? For Darwin, a doctrine of design that included evil and suffering was not worth embracing.

But Darwin still had to explain beauty and goodness, so he continued to waiver. In 1874 Gray wrote an article for *Nature* that was essentially a tribute to Darwin. After discussing his contributions, Gray said:

> Apropos to these papers, which furnish excellent illustrations of it, let us recognise Darwin's great service to Natural Science in bringing back to it Teleology: so that, instead of Morphology *versus* Teleology, we shall have Morphology wedded to Teleology.[19]

Darwin's response showed pleasure. He wrote: "What you say about Teleology pleases me especially, and I do not think any one else has ever noticed the point. I have always said you were the man to hit the nail on the head."[20] And near the end of his life, Darwin wrote to his friend T. H. Farrer these words: "[I]f we consider the whole universe, the mind refuses to look at it as the outcome of chance—that is, without design or purpose. The whole question seems to me insoluble, ..."[21]

Why was this an "insoluble" question for Darwin and not for Gray? I believe that there were two closely related factors upon which they disagreed and which led to their different viewpoints. First, as Michael Roberts has insightfully pointed out,[22] Darwin followed the traditional Paleyean view of design and tried to go from design in Nature to belief in God. Gray began with a belief in God and saw design in Nature as a result of that belief.[23]

Another way to say it is that for Darwin, design would be evidence *for* God, whereas for Gray, design would be evidence *from* God. Since Darwin believed that Nature provided examples that would give evidence for a God that either could not or would not eliminate suffering, he preferred to withhold total commitment to design. Gray, on the other hand, knew from Scripture the attributes of God, and therefore could accept the errors, evil, and suffering of Nature within the same theological context that he did for humans. And that explanation relates to the second factor upon which they disagreed: the relationship of free will and predestination or, as Gray put it in the title of one of his articles, design versus necessity.[24] As Darwin's questions about the man killed by lightning and the gnat eaten by a swallow had indicated, Darwin could not reconcile the seeming randomness of certain particular events with an overall, foreordained plan. Either everything was determined or nothing was.

For Gray, the options were not so mutually exclusive. First, Gray took a more global view of design than Darwin did. Gray saw design providing the overall, general plan, but not requiring specific details. Darwin, on the other hand, understood design to be *in* the details. Gray argued that just as not all actions of human beings, who are purposeful agents, are "'products of design'; many are contingent or accidental,"[25] so he could view some phenomena in Nature to be the result of contingent or accidental forces. Thus Gray could accept the elimination of unfavorable variations, for example, in the same way he could accept that, for the elect, God could work through suffering. God caused neither—they are simply a part of a fallen world—but he can use both.

Lessons We Can Learn

I believe that there are at least two lessons that those of us involved in current debates about these matters can learn from this discussion about evolution and design that took place between Darwin and Gray. First, we need to be cognizant of which way we are arguing: are we arguing *from* design *to* God or *from* God *to* design? If the former, then we must be careful to include the whole of Nature—physical and biological, "good" and "bad," ugly and beautiful—and be prepared to answer questions of suffering, evil, and the like. If the latter, then, it seems to me, we must be prepared to accept the fact that science may be done identically by the Christian and the non-Christian, with identical "results," but the connotative meaning will be different. For the non-Christian, the results may be either ends in themselves or the starting points for future work. For the Christian, they are evidences that lead us to greater praise of God.

Secondly, the Intelligent Design movement as well as those opposed to the ID approach need to examine and learn the history of Natural Theology and design, reading both the advocates and the opponents. We have much to learn from Augustine, Ray, Paley, Hume, the authors of the Bridgewater Treatises, Lord Kelvin, and others. These thinkers will help us strengthen our arguments, refine our logic, and understand the limitations of our perspectives.

Finally, we can follow the pattern of civility and humility that both Gray and Darwin displayed as they sought to understand each other's position, to acknowledge strengths in argumentation and to point out weaknesses in reasoning—possibly resulting in part from their knowledge of the history to which I just referred. Their letters were filled with words like "dear" and "friend," and signed with such words as "cordially" and "affectionately." Differences of opinion—clearly and forcefully stated—did not distort or disrupt their relationship. Gray's testimony was respected by Darwin, and Darwin's real confusion was accepted by Gray. They continued to reach out to each other, and their relationship actually served as a bridge that each could cross in their journey toward Truth. We could do worse than emulate their pattern of debating vigorously yet loving genuinely as we interact with one another on this subject that has yet to be fully resolved. ✻

Notes

[1] Cited in A. Hunter Dupree, *Asa Gray: American Botanist, Friend of Darwin* (Baltimore: The Johns Hopkins Press, 1959), 151.
[2] Ibid., 236.
[3] Charles Darwin, *More Letters of Charles Darwin*, ed. Francis Darwin, (New York: D. Appleton and Company, 1903), 252.
[4] Dupree, *Asa Gray*, 266.
[5] Asa Gray, "The Origin of Species" in *Darwiniana* (Cambridge, MA: The Belknap Press of Harvard University, 1963), 44.
[6] Ibid.
[7] Following the publication of *Descent of Man*, a second problem arose for evangelicals, centered on how humans could be moral beings, created in the Image of God, if they were continuous with the animal kingdom. I will not be addressing that issue in this paper.
[8] Charles Darwin, *The Correspondence of Charles Darwin* 8, 1860 (Cambridge: Cambridge University Press, 1993), 303.
[9] Ibid., 106.
[10] Ibid., 224.
[11] Ibid., 258.
[12] Ibid., 275.

[13]Asa Gray, "Natural Selection not Inconsistent with Natural Theology" in *Darwiniana* (Cambridge, MA: The Belknap Press of Harvard University, 1963), 121-2.
[14]Darwin, *The Correspondence of Charles Darwin* 8, 496.
[15]Charles Darwin, *The Correspondence of Charles Darwin* 9, 1861 (Cambridge: Cambridge University Press, 1994), 267-8.
[16]Darwin, *The Correspondence of Charles Darwin* 9, 369.
[17]Cited in Darwin, *The Correspondence of Charles Darwin* 9, note 11, 430.
[18]Charles Darwin, *The Variation of Animals and Plants Under Domestication* (New York: D. Appleton and Company, 1896), 428.
[19]Asa Gray, "Scientific Worthies: Charles Darwin," *Nature* 10 (June 4, 1874): 81.
[20]Charles Darwin, *The Life and Letters of Charles Darwin*, ed. Francis Darwin (New York: Basic Books, Inc., 1959), 367.
[21]Darwin, *More Life and Letters of Charles Darwin*, 395.
[22]Michael Roberts, "Darwin's Doubts About Design" in *Science & Christian Belief* 9 (2 October 1997): 126.
[23]See also Gray's argument against Agassiz in "Natural Selection not Inconsistent with Natural Theology," 126.
[24]Asa Gray, "Design versus Necessity: Discussion between Two Readers of Darwin's Treatise on the Origin of Species, upon its Natural Theology" in *Darwiniana*, 51-71. The article was originally printed in *American Journal of Science and Arts* 30 (1860): 226-39. The two readers were Daniel Treadwell and Asa Gray.
[25]Asa Gray, "Evolutionary Teleology" in *Darwiniana*, 299.

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Book Reviews

Anthropology & Archeology

GENES, PEOPLES AND LANGUAGES by Luigi Luca Cavalli-Sforza. London: Alien Lane, 2000. 207 pages, bibliography, index. ISBN: 071399486X.

This is the fourth book Cavalli-Sforza has authored or co-authored. The most influential was the massive *History and Geography of Human Genes*, written with P. Menozzi and A. Piazza. The first two chapters consist of an introduction to population genetics, genetic distances, and a discussion of the issue of race. This is all done at a popular level and is not difficult to follow. In the third chapter, the author discusses the Out-of-Africa view of human origins, which is the popular view that modern man arose 120,000 years ago and replaced all the archaic humans on the planet with little genetic contribution from those people. He discusses the search for both the mtDNA Eve and the Y-chromosome Adam.

The fourth chapter details the genetic evidence for past human migrations associated with the invention of farming, a controversial view first proposed by Colin Renfrew. The fifth chapter compares linguistic families with genetic groupings, showing that these independent lines of evidence support each other. Linguistic families delineate, in large measure, biological descent. The final chapter discusses how culture and cultural transmission of ideas affect human evolution. The book achieves many of the author's goals in determining past migrations.

The most important issue raised concerns our relationship with the archaic *Homo sapiens*, such as Neanderthal and *Homo erectus*. Cavalli-Sforza states categorically that Neanderthals left no genetic imprint on modern humans and that there is no evidence of any Neanderthal/Modern human hybrids. These statements are not supportable with the data at hand. He ignores the Portuguese Lagar Velho child found, who shows hybrid characteristics of both modern humans and Neanderthals. He also ignores fossil evidence from Central Europe that indicates hybridization between the two populations. The correct thing would have been to acknowledge the data and then say why it is not evidence of hybridization. Ignoring data is the worst thing a researcher can do. He also cites the recent isolation of Neanderthal mtDNA as showing that there was no Neanderthal input to modern populations. Merely stating this does not make it so. This claim is also inconsistent with what the author says (p. 79) about there being lots of women (cousins of mtDNA Eve) living when Eve lived, but that her mtDNA was merely the mtDNA which survived until today. All others failed to survive. Given that Eve's cousins lived at nearly the same time as the Neanderthal mother did and that they did not leave any more mtDNA on earth than the Neanderthal mother, it is difficult to see why the failure to find modern mtDNA in a Neanderthal says anything about nuclear genetics.

The book brings out several interesting historical issues. Women throughout history have been much more mobile than men. Macho types presume that men were the explorers of the world, but genetics clearly shows that women spread much farther and faster than men. This might very well be partially through kidnapping, but the fact is their genes show less evidence of isolation. In the area of linguistics, it is often claimed that languages change so rapidly that only 1,000 years is required to split a language into two daughters. This rapid change means that when one tries to date the origin of human language by means of phonetic alterations, one gets a very recent age (~100,000 years) for the origin of human language. However, this assumes that the rate of linguistic change is constant. Cavalli-Sforza points out (pp. 202–3) that Icelandic language is almost a frozen language. It has changed so little over time that Icelanders are able to read the Norse texts from 1,200 years ago. Old English of 1100 AD is totally unintelligible to a modern English speaker. The stasis observed in Icelandic is due to the isolation of Iceland. There is very little input of new words because there is very little contact with the outside. As one goes further back in time, and populations are more and more isolated from each other, the rates of linguistic change would have been slower. If there were an original common language to humankind as Greenberg has suggested, isolation could possibly slow language evolution to the point where the original language would have existed prior to the time when modern humans arose.

The book is not the best one that Cavalli-Sforza has written. He made too many assumptions consistent with his preferences and did not always cite the latest data. Yet, this is a book by the man who practically invented the techniques of using genetics to determine the past migrations of peoples. As such, one should own a copy.

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JAVA MAN by Carl C. Swisher III, Garniss H. Curtis and Roger Lewin. New York: Scribner, 2000. 235 pages, notes, index. Hardcover; $27.50. ISBN: 0684800004.

Swisher and Curtis work with the Berkeley Geochronology Center. This is their first book and Lewin's sixth book. Lewin is a science writer who has written extensively on human origins alone and with Richard Leakey. This book covers the events surrounding the 1993 publi-

cation of the first firmly dated evidence that *Homo erectus* was in Java between 1.6 and 1.8 million years ago, and the dating of the youngest known *H. erectus*, the Ngandong specimens, which lived within the past 50,000 years.

Prior to 1993, anthropologists believed that *H. erectus* had not left Africa until around one million years ago. *H. erectus*, it was said, could not have left Africa without inventing a new stone tool technology that would enable him to handle new environments away from his home continent. This new dating, in association with the discovery in Georgia of the Dmanisi *erectus* cranium dating 1.8 million years, turned the anthropological world upside down, giving anthropologists a new respect for the abilities of *H. erectus*. Anthropologists had ignored the fact that elephants and lions, also lacking stone tool technology, were quite successful at leaving Africa. These events show that, in general, anthropologists tend to have a lower expectation for the abilities of early humans than biologists have for animals—an amazing bias toward dumbing down our ancestors.

The two new datings present problems for the multiregional view of evolution. This view holds that various *H. erectus* populations in separate localities evolved into modern man. The Sangiran specimen, which had been believed to be 700,000 years old, was a key piece of evidence for regional continuity. Sangiran was said to show features that modern Australian Aborigines possess. But when it dated at nearly 1.7 million years old, it stretches out the time regional continuity must work and most anthropologists do not believe this is possible. The Ngandong specimens, which dated as young as 38,000 years old, present a similar problem for multiregional continuity. They are too recent to have evolved into modern humans.

None of the data presented rules out interbreeding between anatomically modern humans and *erectus*, which would then transmit their genes into the modern population. The description of the Ngandong fossils, which have been professionally described at various times as *H. sapiens* and *H. erectus*, demonstrates that these fossils share *sapiens* and *erectus* traits. It is unfortunate that the authors do not investigate the possibility of interbreeding as the cause of this trait sharing.

The book sheds some fascinating light on some canards, which have been passed around in apologetical circles concerning Eugene Dubois, the discoverer of *H. erectus*. The claim is often made that Dubois hid the fossils from view, maybe under the floor of his house, in order to keep other researchers from seeing his fossils. This is not true. Dubois had let Gustav Schwalbe view the fossils and Schwalbe gained much fame from his work. Dubois decided that if he was to leave a mark on the bones he himself had found, he needed to restrict the access to his fossils until he had written his description of the bones.

The other canard discounted by this book is the claim often made that Dubois, late in life, had acknowledged that his fossils were nothing more than a big gibbon. Most anthropologists had dismissed Dubois' discovery as a primitive human. Dubois was trying to demonstrate to the world that his fossil was a missing link by comparing it with an extinct gibbon. Placed in this light, the apocryphal apologetical stories should be corrected.

The book delves deeply into the politics of anthropology, displaying in all of the gory details the break-up of the Institute of Human Origins, which had been founded by Donald Johanson. The Institute was the marriage of the Berkeley Geochronology Center and Johanson's institute. For those who want to find dirt on Johanson, this is the place to get it (although another recently published book is even more devastating to Johanson's professional career). Johanson is described very poorly here. Of course, this is only one side, but in fact the Institute of Human Origins was found guilty of a violation of public trust and has since shrunk in importance.

The book is informative of science, its methods, its politics, and its egotism. It is also historically informative concerning events early this century in Java when important anthropological discoveries were being made. This is a book that should grace the shelves of anyone interested in anthropological issues.

Reviewed by Glenn Morton, Ramsden House, 105 Malcolm Road, Peterculter, Aberdeen AB14 0XB, Scotland.

IN THE FOOTSTEPS OF EVE by Lee R. Berger with Brett Hilton-Barber. Washington, DC: National Geographic, 2000. 310 pages, index, bibliography. Hardcover; $26.00. ISBN: 0792276825.

Berger, director of the paleoanthropology unit at the University of Witwatersrand, is the successor to the legendary Phillip V. Tobias and Raymond Dart, two giants in the field of anthropology, who are the only two previous occupants of that position. During Berger's tenure, important discoveries have been made, including the discovery of human footprints that date to 117,000 years ago, the discovery of a nearly complete australopithecine skeleton, and the discovery of the oldest human infant at Drimolen. Berger's first book is sure to be controversial for two reasons: (1) he argues that "Lucy," the *Australopithecus afarensis*, has nothing to do with human evolution and (2) he openly criticizes several world famous anthropologists.

This book is poorly organized, jumping from topic to topic. By starting off with a discussion of the fossil footprints, one thinks the book is going to be about anatomically modern man but that is not to be the case. The authors then turn to what is the main issue on their mind, the advocacy for *Australopithecus africanus* as the human ancestor. They spend several chapters discussing this. While "Lucy" has a more human-like body (long legs and short arms), she has a very primitive skull. This is unlike the earliest members of the genus *Homo*, which have short legs and long arms as does *africanus*. *Africanus* on the other hand has a very advanced skull. Berger and Hilton-Barber argue that it would be unlikely for "Lucy"

with human-like arm and leg proportions to evolve back toward the ape-like state in order to be the parent of the earliest members of *Homo*. Instead, they argue that it would be more likely for *africanus*, who already has the leg and arm proportions of early *Homo* to be the progenitor of us. They also cite dental evidence, which contradicts the idea that Johanson's "Lucy" is the mother of us all. Dental traits, seen on earlier hominids, are not seen in "Lucy" but are seen again in *africanus* and earliest *Homo*.

The authors next turn to paleoanthropological politics at Witwatersrand describing (in detail no one wants) how fellow anthropologists behaved badly toward Berger. Berger takes aim at Ron Clarke as well as his former mentor, Tobias, accusing them of violating university rules and grandstanding. This part of the book, while voyeuristically interesting, does not serve science very well. It all sounds a bit petty. And the authors would be much more credible in their conflicts with their fellow anthropologists if they could spell the names of fossil hominid species correctly (see below).

Of interest to apologists, the book says *Australopithecus garhi*, dated to 2.5 million years, was found in association with stone tools clearly raising the possibility that a creature not of our genus made stone tools. More interestingly, the tools made from rocks were carried fifty-nine miles to the present site. This means that this creature had the ability to plan ahead for at least two days and to understand consequences. This is significantly longer than chimpanzees can plan and raises the possibility that this creature would have been able to understand a moral command such as "Don't eat the fruit of this tree." Secondly, the authors point out that the fossil record of the *Australopithecus* to *Homo* transition has been filled in so that it is very difficult to determine who is and who is not a member of our genus. This means that there are lots of transitional forms, something that many apologists stubbornly refuse to acknowledge.

The book has many flaws, scientific and mechanical. One does not expect to see anthropologists misspell the names of fossil species, yet these gentlemen misspell several names, including *garhi*, and *bahrelghazali*. One would be tempted to blame this on Hilton-Barber, the writer assigned by National Geographic to the project, were it not for the fact that Berger, in the introduction claims that the earliest evidence for the exploitation of marine resources is from South African sites for anatomically modern man dated around 120,000 years ago. He seems not to know his own field ignoring the widely acknowledged Neanderthal exploitation of marine resources at La Grotte du Lazaret in Europe 200,000 years ago. There are also production problems. In one chapter, the last line of each page is reproduced on the following page but on one occasion, an entire line is omitted on the next page. While the book was interesting and I learned a bit from it, all in all, it was not the best anthropological book this year.

Reviewed by Glenn R. Morton, Ramsden House, 105 Malcolm Road, Peterculter, Aberdeen AB14 0XB. Scotland.

Education

ACADEMIC FREEDOM AND CHRISTIAN SCHOLARSHIP by Anthony J. Diekema. Grand Rapids, MI: Eerdmans, 2000. xviii + 214 pages, index. Paperback; $22.00. ISBN: 0802847560.

Diekema spent the past forty years in higher education, including twenty years as the president of Calvin College (1976–1996). During this time, the scholarly productivity of the Calvin faculty made a great leap forward. He encountered two academic freedom cases involving Professor Howard Van Till (ASA president, 1991) and Professor Hessel Bouma III (ASA fellow).

In the Introduction, he points out that we are in the new era of changing from the Enlightenment to the post-Modern period. Christian colleges must help to guide the community of faith during this transition by providing perspective and insight.

In the next chapter, he proposes a definition of academic freedom as a principle "to protect professors from those forces which tend to prevent them from meeting all their obligations in the pursuit of truth." In the third chapter, he enumerates several threats to academic freedom such as ideological imperialism, dogmatism, political correctness, intolerance of religion, prior restraint, and censorship. As an example of censorship, Diekema gives a four-page description of the Van Till case which occurred after the publication of his book "The Fourth Day" in March 1986. At the end, based on French sociologist Émile Durkheim's work on community, Diekema urges the academic community take up vigilance against the threats of academic freedom.

In chapter four, Diekema emphasizes that academic freedom for Christian colleges should be anchored in the Christian world view. This world view is the boundary of academic freedom. Due to the influence of postmodernism, people realize that an unbiased, objective, ideology-free inquiry of truth is a myth. So holding a Christian world view becomes legitimate. Diekema believes that the Christian community of scholars should expose the fallacy of belief in reason only and work against its dominance over all other world views.

In the fifth chapter, Diekema presents a proposal for policy development about academic freedom in the Christian colleges based on his extensive experience. He finds that the tenure system is not needed and could be replaced by a Socratic covenant similar to the Hippocratic Oath taken by physicians. He states that academic freedom is essential for promotion of scholarship in Christian colleges. About the relationship between a college and the supporting denomination, he requests mutual respect and thinks that colleges should not fill the role of giving catechetical instruction.

In the final chapter, Diekema reflects and summarizes his thought on academic freedom and encourages all

Christian colleges to move toward an ethos of freedom. The book ends with an expanded statement of the mission of Calvin College adopted in October 1992.

Here is an articulate and informed discussion of academic freedom which combines extensive research with the author's personal experience. Since many ASA members are professors at Christian colleges, this book should be highly relevant and the proposals given should be debated. I agree with most of his ideas.

However, regarding the influence of postmodernism, I think the area of natural science is least affected because of its objectivity. That is why the Van Till case could be defended under various world views. For other areas of inquiry, because of limitation of methodology and complexity of subject, different world views can play a legitimate role in scholarship. Still, the Christian faith holds that world views will be unified when Christ returns. Meanwhile, Christian scholars need to demonstrate with good teaching and research that the Christian world view is beneficial for society.

Diekema proposes that Christian colleges develop first-rate scholarship with graduate programs and in-house research. Instead, I think Christian colleges should place their emphasis upon undergraduate education, so that alumni can be trained in other good research universities and become first-rate Christian scholars. In my opinion, to remain as undergraduate colleges is better than aspiring to be research universities with graduate programs.

Regarding the relationship between churches and colleges, I think it is essential to focus on Christian education in Christian colleges, especially for the humanities major. Due to the shortage of sound Christian education in some churches and the rampant biblical illiteracy of young people, Christian colleges need to do remedial biblical education and have a firm commitment to produce lay and clerical leaders and teachers for their churches.

Reviewed by T. Timothy Chen, Professor of Biostatistics, University of Maryland Medical School, Baltimore, MD 21201.

Environment

ENVIRONMENTALISM UNBOUND: Exploring New Pathways for Change by Robert Gottlieb. Cambridge, MA: MIT Press, 2001. 396 and xvii pages, bibliographical references, and index. Hardcover; $29.95. ISBN 0262072106.

Gottlieb's book shows that some happenings right around us, which we accept as normal, may contribute heavily to pollution. For example, North American governments defend at international conferences the use of automobiles, since they are needed to get to work. Of course, producing cars is good for the economy as well. So exceptions in pollution-control ensue for North America while other countries face controls. Thus, worldwide pollution increases.

Gottlieb points to some causes of increased use of automobiles in North America. Since factories in inner cities pollute, people move to the suburbs looking for a cleaner environment. Fleeing the city means, however, that workers use more fuel. Thus, more pollution results. And, when people leave the inner city it is even more neglected, and the environment becomes even dirtier. More people flee, more polluting occurs, and the vicious circle continues. Gottlieb states the problem well by quoting Raymond Williams: "The consumer wants only the intended product ... all other products and by-products he must get away from, if he can. But get away—it really can't be overlooked—to treat leftover nature in much the same spirit: to consume it as scenery, landscape, image, fresh air" (p. 43).

The author points out that workers living close to factories are often too afraid to complain about the environment in which they live for fear that they will lose their job. Progress is being made though. More voices are now heard who want to clean up inner cities.

A section entitled "Exploring Pathways" gives some examples of improvement through the cooperation of workers, employers, and scientists. For instance, a dry cleaner must work where people live and/or work. His work requires the use of chemicals. He has to dispose of dirty, polluted water. The chapter shows that improvement is possible when scientists (who have to invent chemicals to clean clothing, and chemicals to clean dirty water), dry cleaners, trade-organizations, governments and people cooperate.

Another section talks about janitors, their work environments, and their employers. While dry cleaners are often self-employed, janitors are usually employees. Who is responsible for the chemicals used to clean? Who is responsible for the health of the janitors? How do they dispose of dirty water?

Also discussed is the food supply and the changes occurring in producing it. What are the consequences when small farms are taken over by big companies? This book talks about Monsanto. What are the responsibilities of the company and its workers, which include scientists?

The author discusses strategies at ecological improvement. He uses as an example efforts to improve water and parks in Los Angeles. This involves governance strategies, politics, the value of work, remaking industry, and cataloging assets. By social and ecological movements joining hands, progress can be made. I recommend this book to everyone, because everyone wants to live in a clean and productive environment.

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

Ethics

BIOENGAGEMENT: Making a Christian Difference through Bioethics Today by Nigel M. de S. Cameron, Scott E. Daniels, and Barbara J. White, eds. Grand Rapids, MI: Eerdmans, 2000. 280 pages. ISBN: 0802847935.

Ethical issues are critical in health care areas. This book, from a conference sponsored by the Center for Bioethics and Human Dignity, tackles this challenging area. The diverse contributions include views on bioethics from the areas of theology, education, the media, law, policy, health care pragmatics, and the church. With new and challenging bioethical issues, now more than ever, Christians must be "salt and light" in the world.

The first section asks "Why bioethics?" and "What do we learn from the Bible?" Sir Brian Mawhinney, a British statesman, focuses on political issues, while others focus on theological or other related issues. The concluding note is that there is a strong biblical imperative to engage the culture through various means, and the following sections on education, media, law, policy, medical practice and the church continue this theme.

Educational and media issues, the focus of section two, involve communication. Communicating relevant Christian messages to the church, schools, and society is essential. The discussion of postmodern approaches to university teaching is more self-pitying than it might have been. Christians have always been called to carry their crosses, but joy and hope are also essential Christian qualities. Teri Goudie, a media expert, focuses positively on getting our message across by being prepared and assertive in interviews. Mary Adam's piece on sex education notes that abstinence, the only 100% effective birth control method, was and is downplayed in many areas. She also focuses on the positive work being done to reintegrate Christian ethics into sex education.

This focus on education brings the discussion quite naturally to policy issues, and in this section, comments by lawyers and politicians deal with such challenging issues as human embryos, in vitro fertilization, ownership and rights of fetuses, euthanasia, and related life and death issues. Information on previous court decisions, reasoning and possible policy directions is well presented.

The fourth section focuses on health care, primarily from the point of view of doctors and nurses. How can health professionals provide moral leadership, remain compassionate, and act in ethical ways in a litigious, rationalistic environment? Can medical education be improved in ethical areas? These and other questions, including an interesting piece on disabilities by nurse Linda Treloar provide much food for thought.

The final section focuses on the church, which can be a leader in ethical areas. Terry Schlossberg notes that few pastors preach on abortion. Sadly, with 1.5 million abortions annually, this is too big an issue to avoid. Other authors focus on teaching, authority, church interaction with society and return again to the theme of the biblical context for bioethics.

BioEngagement presents a diverse collection of Christian views on bioethics and healthcare. However, bioethical issues are broader than this. Creation care (environmental) ethics are also biblically mandated and challenging today. Questions on genetically modified organisms, rights of others, and teleological issues are not discussed in this book. Nevertheless, as a current broad approach to ethical issues in the medical professions, this is an excellent contribution.

Reviewed by Steven G. Hall, Louisiana State University, Baton Rouge, LA 70803.

EVOCATIONS OF GRACE: Writings on Ecology, Theology, and Ethics by Joseph Sittler. Edited by Steven Bouma-Prediger, Peter Bakken, and Martin E. Marty. Grand Rapids: Eerdmans Publishing Company, 2000. xiii + 242 pages, notes, selected bibliography, indexes. Paperback; $20.00. ISBN: 0802846777.

It was a joy to read this book. The editors gathered ten essays, speeches, and lectures which Sittler produced between 1954 and 1975; Bakken wrote the Introduction, and Bouma-Prediger wrote the Conclusion. Bakken mentions Lynn White Jr.'s 1967 essay in which he states that Judaism and Christianity were the original cause of the degradation of nature because of their misunderstanding of Gen. 1:28. That verse instructs humankind to "have dominion" over nature which was interpreted to mean "develop as much as you can."

We read in this book, however, that Sittler (1904–1987) was in the forefront of Christians protesting the way people treat nature. In 1954, thirteen years before White's essay, Sittler wrote in an essay titled "A Theology for Earth":

> One finds nowhere in the Bible that strange assertion which one hears almost everywhere else ... that God is concerned to save men's souls! How richly, rather, restoration is presented in terms of men's material involvement in the world of nature (p. 29).

Sittler thought Christian theology should articulate a theology of nature: "For it is precisely in this area that the systematicians have historically made pretensions of the most massive asininity, betrayed the most broad-backed insensitivity, and have been most blind to the revelatory fact" (p. 21). Sittler realized the importance of being a citizen of the earth as well as being a professor of Christian theology.

The book's title indicates Sittler was well aware of the necessity of grace, but it should be grace in all areas of human life. The reader will sometimes ponder Sittler's

view of the relationship between nature and grace. In 1968 Sittler wrote:

> When this grace—for that is the lovely name for the presence and work of the spirit in both Jewish and Christian communities—seems to have departed from the secular city as neither affirmed, sought, nor desired, or when God is dead—that departure and that death is but the fateful report that realities that belong together have come apart (p. 75).

That modern man destroys nature is clear, and Christians often participate in this destruction. This book is a wake-up call reminding Christians that faith has consequences for every area of life. Faith involves doctrine, but faith also has consequences for everyday living in the world of nature. I recommend this book although it requires some effort to understand parts of it. It will provide many insights and some joy as well.

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

Faith & Science

SCIENCE AND FAITH: An Evangelical Dialogue by Harry L. Poe and Jimmy H. Davis. Nashville, TN: Broadman & Holman Publishers, 2000. 259 pages, index. Paperback; $19.99. ISBN: 0805421424.

Poe currently serves as vice president of Academic Resources and Information Services and professor of Christian Studies at Union University in Jackson, Tennessee. Davis is a professor of chemistry there and is also the associate provost of the College of Arts and Sciences. Together they won a Templeton Award for their course on science and faith at Union University. As stated in the preface, this book was written "primarily for Christian college students and their teachers who struggle with how to believe the Bible and accept modern scientific discoveries at the same time."

What can we know and how do we know it? What kind of universe exists? Where did we come from? What can we know with certainty? When is order disorder? These five questions introduce the five major sections of the book. Each question is addressed by three chapters: the first presenting the scientific perspective, the second providing an "Evangelical Christian" perspective, and the third devoted to a dialogue between the two positions. Topics addressed by these five questions include epistemology, cosmology, origins, quantum mechanics, and chaos theory, all of which are appropriate topics for a text on science and religion.

One strength of the book is the clear and concise coverage of these topics. Important scientists and their contributions are described from a historical perspective with numerous charts and diagrams included to help the reader better understand difficult concepts and theories. One concern regarding the topics is the omission of any discussion of the relationship between science and the environment. An additional question could have been added, "What is our relationship with the natural world?" that would then be answered from both a scientific and biblical perspective. Recent publications by evangelical Christians have argued that there is much common ground between science and biblical theology in the areas of ecology and environmental biology. Including a discussion of this common ground would have strengthened this book.

The chapters written from a religious perspective are for the most part in agreement with the answers to the five questions that are suggested by the discoveries of twentieth century science. The authors reject a conflict and independence relationship and "believe that the dialogue and integration categories are the appropriate modes for relating science and religion" (p. 38). They also feel that the concepts of consonance and dissonance are helpful, and they use this consonance/dissonance approach in their "dialogue" chapters. While Poe and Davis believe that the scientific way of knowing is valid for understanding the physical world, they argue that the Christian approach to knowledge assumes that a spiritual realm also exists and that God communicates with people in a variety of ways. They are able to avoid conflict with the scientific account of creation by suggesting that the creation accounts in Genesis are not meant to be interpreted literally.

While the Bible clearly teaches that God is the Creator of the universe and human life on earth, it does not say exactly how God carried out this creation process. According to the authors:

> God laid down an allegorical veil on the timing of the end in Revelation, while revealing what would happen at the end. At the other end of time, God may have done the same thing with regard to the timing of the beginning while revealing the fact of creation (p. 47).

In the chapter which provides a religious response to the scientific understanding of quantum theory, consonance is proposed among the discoveries of quantum mechanics, the incarnation, and the doctrine of the trinity. In a later chapter, a connection is made between chaos theory and God's use of chaos to accomplish his purposes. The authors suggest that chaos theory has implications for understanding the relationship among God's sovereignty, the ongoing process of creation, and human free will. While the Bible clearly teaches that God has absolute power over time and eternity, chaos theory implies that the exercise of this sovereignty appears to be more artistic than totalitarian. The biblical model of God as "Shepherd" vividly portrays how God exercises sovereignty. Chaos theory is further discussed in relation to the return of Christ and other aspects of biblical eschatology.

Although much of the book is an attempt to find consonance between current scientific theories and evangeli-

cal theology, the authors state that in the final analysis, the Bible must provide the basic resource for theology rather than science. While most recent books on science and religion are mainly concerned about what science can teach us about theology, these authors are to be commended for also emphasizing what the Bible can teach us, as many biblical quotations and references are included. This book could be improved by adding a section on ecology, a bibliography, and more notes for those who would like to explore particular topics in greater depth. But it does provide a basic introduction to the present dialogue between the disciplines of science and religion from a biblical and evangelical perspective.

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

THE FUTURE OF THE UNIVERSE: Chance, Chaos, God? by Arnold Benz. New York: The Continuum Publishing Group, 2000. 176 pages; index. Hardcover; $24.95. ISBN: 0826412203.

This book was originally published in German in 1997 and has since been translated into five other languages. Benz is a professor of astrophysics at the Swiss Federal Institute of Technology in Zurich. He has written two textbooks and over two hundred scholarly papers. Benz has a web site devoted to this book at http://helene.ethz.ch/papers/benz/zukunft/future.html.

The book is actually more general than the title indicates. Although Benz does emphasize the future of the universe, he also presents his broad personal perspective (as a Christian and astrophysicist) of the relationship between science and Christianity. He does not view the relationship as direct because science is objective while Christianity is personal. Science and faith are two partially exclusive approaches to the same reality; they are two nonintersecting planes that both intersect the common plane of human experience. Therefore, they interact indirectly. For example, the two things that amaze humans the most are science and faith. Similarly, we encounter reality in both science and faith that engenders experiences which cannot be completely expressed by words. And finally, religious faith allows us to hope in that which science cannot explain, such as the resurrection.

We view the inevitable end of the universe with the same discomfort that we contemplate our personal deaths. But just as God promises a personal resurrection (in spite of its scientific implausibility), so he also promises a new creation (despite the second law of thermodynamics). The resurrection of Christ is a metaphor for a new creation that will follow the passing away of the old creation. Benz interprets the scientific view of the future of the universe in the language of Christianity. The hope of resurrection and new creation is a gift which we can choose to receive.

Benz tries not to presuppose specialized knowledge from his readers. Throughout the book, he relates many fascinating personal observations about how his involvement in science impinges upon his religious experience. The book is full of solid and interesting information about how physics arrives at its conclusions of how the universe came to be and where it is going. Benz notes that astronomical objects were formed not only at the big bang, but continue to form on a continual basis. So God continues to create even today.

Benz purposely distances himself from the intelligent design camp. He states that "the creator has left no fingerprints behind." God reveals himself not through nature but through the "life of a human being who believes." He says that we should not make too much of the fine-tuning of the universe because we do not yet understand it.

Benz's integration of science and Christianity seems indirect, awkward, difficult to follow, and overly subjective. Although he is a Christian, there is nothing distinctively Christian about his approach. I can picture a similar book being written from the perspective of any other religion (Hinduism, Islam, etc.). I tentatively recommend this book to those who are interested in an original, metaphorical, and meditative integration of science and religion.

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

THE CASE FOR FAITH: A Journalist Investigates the Toughest Objections to Christianity by Lee Strobel. Grand Rapids: Zondervan Book House, 2000. 300 pages. Paperback; $12.99. ISBN: 0310234697.

This book, reasonably priced, packs a big wallop! In developing rational responses to hard questions confronting Christianity, Strobel provides intellectual arguments that can strengthen the faith of laity and laypersons alike. Many apologetics books of this kind are pretty tough reading and are frequently more soporific than they are terrific. No so with this volume. It will stimulate and inform throughout. One of the reasons is that much of the material is presented in a dialogue format involving Strobel and noted Christian apologists. In other words, it is a discussion rather than a sermon.

Strobel bases his presentations on a discussion with Charles Templeton. After being successful as an evangelist (and a close friend of Billy Graham), Templeton became a skeptic and eventually an agnostic. Why? Because of a photo in *Life* magazine. In Templeton's own words:

> It was a picture of a black woman in Northern Africa. They were experiencing a devastating drought. And she was holding her dead baby in her arms and looking up to heaven with the most forlorn expression. I looked at it and I thought, "Is it possible to believe that there is a loving or caring Creator when all this woman needed was rain?"

After recounting his discussion with Templeton, Strobel tells of his visit to eight scholars. He allows each

of them to respond to an objection to the Christian faith held by Templeton and other skeptics. For example, Peter John Kreeft deals with this objection: "Since Evil and Suffering Exist, a Loving God Cannot." Other objections presented are: "Since Miracles Contradict Science, They Cannot Be True" answered by William Lane Craig; "God Isn't Worthy of Worship If He Kills Innocent Children" dealt with by Norman L. Geisler; "A Loving God Would Never Torture People in Hell" critiqued by J. P. Moreland; and "I Still Have Doubts, So I Can't Be a Christian" responded to by Lynn Anderson.

Each respondent does a commendable job in dealing with these objections. As you read the book, you may wish that you could have been included in the dialogue. Perhaps no answer deals a knockout blow to the skeptic, and there are surely other questions which the doubter could pose. On the other hand, if the evidence were overwhelming, everyone would believe. Ultimately, the Christian walks by faith, not sight; by hope, not by proof.

So in conclusion, I highly recommend this book. I wish I had read it in college when I was troubled by Thomas Paine's *Age of Reason*. It would be a good choice for a gift to an inquiring friend, or an addition to your church library.

Strobel is a former atheist. He holds a law degree from Yale and won an award as legal editor of the *Chicago Tribune*. Presently he serves as a teaching pastor at Saddleback Valley Community Church in Orange County, California. He is the author of *The Case for Christ* and *Inside the Mind of Unchurched Harry and Mary*.

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

HOW NOW SHALL WE LIVE? by Charles Colson and Nancy Pearcey. Wheaton, IL: Tyndale House Publishers, 1999. 574 pages. Hardcover; $22.99. ISBN: 0842318089.

This book popularizes *world views* as consisting of answers to ultimate questions and encourages Christians to engage culture in the battle of world views. Chapters 5–9 primarily discuss cosmology and evolution; chapter 40 discusses the Christian origins of science. Colson and Pearcey are to be commended for showing the role of science in contemporary world views and the functioning of theism in the scientific revolution. It is regrettable, though, that the citations on Christian origins of science constitute a narrow slice of a broader historiographical literature, as adherence to positivistic readings in Pearcey's publication with Thaxton of *The Soul of Science* (sections of which reappear here) was critiqued earlier [Sara Miles, *Christian Scholar Review* XXIV (1995) 496–8]. A number of other science problems hamper the book's achieving its goal; in most cases, their thesis remains defensible, but many of the arguments are too simplistic.

The authors at times demonstrate cynicism about the scientific enterprise: "... no one is asking critical questions about what [amino-acid/life] experiments really prove" (p. 70). Secular science is depicted as elevating perceived victors over religion: for his attempts to "create life ..., [chemist] Sidney Fox ... was promptly inducted into the Modern Hall of Scientific Heroes" (p. 70). Young Christians will not consider science a worthy pursuit if we make caricatures of science.

The authors state: "We should not oppose science with religion; we should oppose bad science with better science" (p. 61). While quoting the Bible may not seem helpful, one of our goals is to remind scientists of their unacknowledged metaphysical and other presuppositions. But "better science" is not well modeled in the book; there are many relevant errors used to advance arguments. Stating that "*the* task for Christians ... is ... to expose the flaws in scientific naturalism" (p. 422, italics mine) emphasizes reaction instead of promoting science as obedience to the cultural mandate.

Colson and Pearcey cite big bang theory as evidence against naturalism and for divine creation, since science has to stop there, so there was a beginning and a Creator. But big bang theory may, as some cosmologists suggest, be only a passing fad. Even if science could prove there was a beginning (the entropy considerations [p. 58] *do not* rule out bouncing universes [A. E. Sikkema & W. Israel, *Nature* 349 (1991) 45–7], that would be no more evidence for a Creator than an infinite past; the Creator's role is not just in an initial moment [W. E. Carroll, *First Things* 97 (1999) 18–20]). Calling Stephen Hawking's imaginary time approach "little more than fantasy" (p. 60) is unjust, since this complex-number technique is used by theoretical physicists to compute measurable quantities. Since scientists often encounter novel phenomena challenging common sense, one cannot, as the authors suggest, limit science to "established laws of experience" (p. 60).

Colson and Pearcey present well the amazing fact that many physical quantities are finely tuned for life (the anthropic principle) as evidence for a Creator. However, it is not true that "there is ... no natural explanation for the precise balance in the electrical charges of the proton and the electron" (p. 64), as Glashow-Weinberg-Salam electroweak theory (1960s) connects conservation of charge to this balance.

The authors state: "Greeks expected to find a certain lack of precision in nature, a fuzziness around the edges ... Christians expected the order in nature to be precisely what God wanted it to be—mathematically precise" (p. 424). If so, the Greeks were right and Christianity is wrong: two twentieth-century developments, quantum mechanics and chaos theory, show nature *is* fuzzy around the edges. The authors continue: "Kepler was convinced that everything in creation is precisely the way God wants it to be ... " (p. 425). Since planetary orbits were not exactly circular, "they must be *exactly* something else ... he finally hit on the discovery that the orbits are ellipses ... [What] spurred him on [was] his conviction the biblical God has complete control over matter and, therefore, it will be mathematically precise." Kepler's work

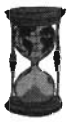
was real progress, but not because the orbits are exactly elliptical, for that occurs only in the abstract: when two point particles interact gravitationally in an otherwise empty universe. Real orbits are only *approximately* elliptical; variations are due, not to a divine lapse, but, for example, to effects of moons and other planets. As pointed out in another review of *Soul of Science*, the reader is left with a universe which seems more mathematically ordered than it is [C. Menninga, *Calvin Theological Journal* 30 (1995) 585–9].

Colson and Pearcey write that "Nature is orderly and predictable. [B]efore modern times, most people regarded nature as mysterious, dangerous, and chaotic" (p. 423). But chaos (exponentially-sensitive dependence on initial conditions) is ubiquitous, for example, rendering weather unpredictable, and who would argue that quantum mechanics (which limits predictability as well) is not mysterious or that tornadoes are dangerous? Nature is not as utterly orderly, predictable, or tame as Colson and Pearcey present Christianity as implying.

Finally, Colson's broad readership will benefit from being made aware of the challenge the intelligent-design movement poses to dogmatic neo-Darwinianism, but it would have been helpful to point out that Christians debate it as well (it perhaps over-emphasizes the role of reason in recognizing God).

I would recommend the book for anyone wishing an introduction to a creation-fall-redemption world view together with model applications in many areas of life. It remains important for readers to be aware of the defects of this widely-read book's science aspects.

Reviewed by Arnold E. Sikkema, Physics Dept., Dordt College, Sioux Center, IA 51250.



History of Science

EINSTEIN, HISTORY, AND OTHER PASSIONS: The Rebellion Against Science at the End of the Twentieth Century by Gerald Holton. Cambridge, MA: Harvard University Press, 2000. 240 pages, notes, index. Paperback; $18.50. ISBN: 0674004337.

Holton holds a joint appointment as Mallinckrodt Professor of Physics and Professor of History of Science at Harvard University. He is the author of several other Harvard University Press books including *Thematic Origins of Scientific Thought, Science and Anti-Science, The Advancement of Science and its Burdens*, and *The Scientific Imagination*.

This book is in two parts: the first, a presentation of some thoughts on how the modern impersonal approach in science came to be; and the second, a brief biography of Einstein. In the first part, Holton outlines the various roles science and scientists have played throughout history. Holton believes the human side of science is frequently ignored and is a factor in the rejection of scientific thinking in our postmodern world. Furthermore, he believes that the various social, cultural, and intellectual influences to which people are exposed during their formative years have a major influence on the extent to which they accept this impersonal world view that is associated with modern science. This theme is developed further in Part II as Holton reveals a passionate and very human Einstein through an analysis of his writings. I was most fascinated by the chapter in which Holton revealed the love correspondence between Einstein and his first wife, Mileva Maric.

Holton's book is not involved with the interface between science and faith, as many of the books reviewed for *PSCF* are. However, Holton's emphasis on the effect the world view of the scientist has on his science stimulated reflection on how my Christian commitment has influenced my career. Furthermore, I have gained insights from reading this volume that will be useful in presenting the scientific method to my introductory chemistry and physical science classes. I enthusiastically recommend this book to the ASA members and their colleagues.

Reviewed by Elizabeth Hairfield, 325 Winthrop St., Staunton, VA 24401.

Origins

SPARKS OF LIFE: Darwinism and the Victorian Debates Over Spontaneous Generation by James E. Strick. Cambridge, MA: Harvard University Press, 2000. xi + 283 pages, glossary, timeline, index. Hardcover; $45.00. ISBN: 067400292.

The origin of life has been of enduring interest. Aristotle strongly advocated "spontaneous generation" arguing that it was observed *fact* that some animals spring from putrid water, that plant lice arise from the dew that falls on plants, that fleas emerge from decaying matter, etc. With the invention of the microscope previously invisible life forms became further candidates to emerge from nonlife. Skeptics had little on which to base their claims until Italian physician Francesco Redi experimentally demonstrated (1668) that maggots did not appear in meat in which flies were prevented from laying their eggs by wire screens. Later workers gradually demonstrated that the higher animals were not spontaneously generated from the nonliving; microorganisms—the monads and bacteria—were another matter.

The debate waxed and waned in Europe through the eighteenth and nineteenth centuries until the late 1850s when the pot boiled over in England catalyzed by contributors from France and Germany. In exploring the English scene from 1860–1880, Strick has done a masterful job in drawing together a large cast of characters with changing ideas and motives; clashing personalities; and conflicting science, medical theories, politics, and experiments.

Sadly, for this naive chemist, it was not experiments that won the day for the anti-group of T. H. Huxley, John Tyndall, Charles Darwin, and their cohorts against H. Carlton Bastian, an outspoken advocate of spontaneous generation. Power science politics, control of strategic teaching venues, plus *experiments* put the matter to rest after 1880—for a time. Today, the matter has been turned on its head with a variety of *synthetic experimental* strategies suggesting how increasingly complex forms of primordial matter may have come to the point of life.

Strick has written an engaging account of the fighting among Darwinian factions over spontaneous generation. The winners were able to distance the radical implications of spontaneous generation from evolution and thus ease the task of gaining public acceptance of Darwin's ideas.

Sparks of Life belongs in science libraries and on the shelf of biologists concerned with the development of the major motif of their field.

Reviewed by Jack W. Haas, Jr., 3 Villa Rd., S. Hamilton, MA 01982.

THE CREATION OF MAN AND WOMAN: Interpretations of the Biblical Narratives in Jewish and Christian Traditions by Gerard P. Luttikhuizen, ed. Boston: Brill Academic Publishers, 2000. 214 pages. Hardcover; $70.00. ISBN: 9004116710.

This book is a collection of twelve essays delivered at a June 1999 conference held at the University of Groningen, the Netherlands. It is the third volume in the series, Themes in Biblical Narrative: Jewish and Christian Traditions, the proceedings of the yearly Groningen conferences. The editor and other contributors are university professors of biblical languages or theology. All but two of the contributors work in the Netherlands. All essays are in English.

The essays interact with the biblical accounts of the creation of man and woman from various perspectives. The first chapter places the Genesis accounts in the broader context of ancient Near Eastern literature. The next eight chapters examine various Jewish, early Christian, and Gnostic interpretations of the Genesis accounts, 1 Corin. 11:2–16, and a Gnostic work, *The Secret Book of John*. The last three chapters deal not with ancient interpretations but with more modern ones: Milton's poetic retelling in *Paradise Lost*, a feminist interpretation of the Genesis creation stories, and a psychological analysis of the Genesis account as a model for human creativity. None of the essays is written from an evangelical perspective; all employ the canons and methods of higher criticism in handling the biblical texts.

I was disappointed in the book. The higher critical perspective was not the problem: evangelicals in science interact with non-evangelical material all the time. The unsatisfactory aspect of the work was the complete absence of any attempt to interpret the biblical text in light of the discoveries of science. If the essays contained in this volume are representative of the interests and concerns of biblical scholars today, evangelicals in science can expect no help from them in our efforts to reconcile the Word of God and the facts and theories of science. Probably only evangelical interpreters see a need to reconcile biblical faith and science; those who view the Scripture as myth would have no motivation to do so.

In two essays, the door was open, but the interpreter chose not to walk through it. One contributor states: "In Genesis 1:11, the earth is co-creatrix: 'Let the earth put forth vegetation.' But this role is limited; everything happens according to the word of Elohim" (p. 8). But he fails to comment on the implications of this conclusion for theistic evolution or for the view, urged by Van Till, that God created the world with robust functional integrity. Again, another contributor refers to the Copernican Revolution (p. 192), but finds its effect to be a psychological one: a personal "Copernican shift" within human creators of music, literature, and art allows them to put themselves at the center of their work. He has no comment to make regarding the effect of the Copernican Revolution on Western people's view of the cosmos and on the historical development of the modern objective scientific perspective.

In light of the inattention to scientific issues raised by the biblical creation accounts, as well as the high price of the book, I doubt that it would be of much interest to readers of *PSCF*. Institutions might wish to obtain it for their libraries, but science department libraries would not find it particularly valuable.

Reviewed by Robert Rogland, Covenant High School, Tacoma, WA 98465.

COSMIC EVOLUTION: The Rise of Complexity in Nature by Eric C. Chaisson. Cambridge: Harvard University Press, 2001. 274 pages, glossary, notes, references, index. Hardcover; $27.95. ISBN 067400342X.

Chaisson received his doctorate in astrophysics from Harvard University. He was a faculty member at Harvard and at Johns Hopkins University and presently directs the Wright Center for Innovative Science Education at Tufts University. He has published over one hundred scientific articles and nine books.

Chaisson aims high, even for an astrophysicist. His goal in *Cosmic Evolution* is to build "a cosmic heritage—a grand structure of understanding rooted in events of the past, a sweeping intellectual map embraced by humans of the present, a virtual blueprint for survival along the arrow of time ... nothing less than a holistic cosmology."

Chaisson sets forth his case in five chapters. The Introduction reviews basic concepts of thermodynamics, quantum principles, probability, statistical mechanics, and information theory. He emphasizes the importance of *dissipative structures*, that is, open systems that spontaneously adopt more ordered forms that can handle increased energy flows. The aim of this chapter is to estab-

lish on accepted scientific grounds the possibility of a spontaneous increase in order for a localized part of the Universe.

Chapter one, "Matter," summarizes current thinking about the Big Bang and the expansion of the Universe. Chaisson concludes, "the Universe is indeed expanding at *some* rate sufficient to give rise to [energy] gradient rich environments and thus to increasing amounts of complexity and intricacy during the course of universal history." Chapter two, "Radiation," summarizes current thinking regarding the conversion of radiation to mass in the first few thousand years after the Big Bang.

Chapter three, "Life," argues that the principles outlined in the first three chapters were at work in prebiotic chemical evolution and subsequent biological evolution. "We reason that *cosmic expansion itself is the prime mover for the construction of a hierarchy of complex entities throughout the Universe*" (emphasis in the original). The specific driver of cosmic evolution is *free energy rate density*, that is, ergs of energy passing through a system per second per gram. The observed rise in complexity is nature's way of dealing with increasing free energy rate densities in localized parts of an expanding Universe.

Chaisson applies his theory to biological evolution with as much confidence as he does to cosmology, since "biology is physics with added features." He believes the tendency towards more efficient handling of ever-greater free energy rate densities is at least as important as Darwinian mechanisms in driving biological evolution. Chaisson recognizes that biologists may not jump on the bandwagon right away: "Though utterly foreign among practitioners of the biological sciences, this term [energy rate density] remains straightforward, physically intuitive, robust and inclusive."

Chaisson admits he is painting with a broad brush: "How ... order became manifest specifically in the form of galaxies, stars, planets, and life has not yet been deciphered in detail; that is the subject of many specialized areas of current [research]." He admits of exceptions to the general trend, but dismisses them as "devilish details." Scientists in the specific disciplines where those details raise important questions may be less insouciant.

Like Carl Sagan, Chaisson is an unashamed materialist: "The Universe is all there is, by definition." He sees no progress or design in nature, explicitly rejecting both the strong anthropic principle and the possibility of a Designer. Indeed, Chaisson views his theory as a replacement for religious views:

> The evolutionary epic told here is as ennobling as any religion—enlightening, majestic, awesome, providing a sense of the "ultimate." Material reality, when scientifically analyzed in both breadth and depth, brings to mind not only elegant grandeur and a sacred narrative comparable to any religious tradition, but also enriching empiricism and a genuine connection to the cosmos extending into deep history much older than most religions.

Despite its obvious objectionable features, ASA members would do well to read this book. Those who believe God created a universe with robust functional integrity will want to see if Chaisson's scenario is a possible one. Might God have created out of nothing the radiation of the Big Bang, endowing it with such properties that natural history has fallen out along the general lines of Chaisson's schema? Those not convinced by the functional integrity approach will want to ask themselves the same question. Moreover, ASA members ought to read this book because it creates a materialist mythology, an alternative to creation *ex nihilo* by a transcendent God, which unbelieving colleagues may well embrace. Cosmic evolution is a view ASA members should become familiar with and prepare to answer as Christians in the sciences.

Reviewed by Robert Rogland, Covenant High School, Tacoma, WA 98465.

IMPEACHING MERE CREATIONISM by Philip Frymire. San Jose: Writers Club Press, 2000. 101 pages. Paperback; $11.95. ISBN: 0595001963.

Frymire, a petroleum geologist from Tulsa, is dismayed that a "creationist resurgence" threatens the quality of science education in Oklahoma and the nation. Frymire sees Boalt Hall law professor Phillip Johnson as the principal culprit for the sad state of affairs that has biology educators fighting to keep evolution in the curriculum. The fear is that Johnson's intelligent design movement would introduce supernatural explanations in science and thereby subvert genuine science education. If evolution is, as Dobzhansky claimed, the central organizing principle of biology, then any anti-evolutionary approach that wins popular approval represents a threat to the integrity of biology and must be challenged.

Consequently, Frymire does battle against Johnson in a lively, nontechnical polemic that visits several of the standard criticisms of intelligent design found in the popular scientific literature. Frymire's basic objection with Johnson and the intelligent design movement, as he understands it, is that it is "scientifically useless." It is simply as a gussied-up version of the old creationism. He agrees with Daly and Wilson that this form of creationism is "devoid of empirical implications." Intelligent design theory, Frymire contends, "doesn't explain anything, doesn't predict anything, and is completely untestable."

Frymire begins with a brief objection to Johnson's case against naturalism in science. Given the standard definition of science, Frymire sees absolutely nothing untoward about science's commitment to methodological naturalism. Anything else would not be science. Next Frymire takes on the distinction between micro- and macro-evolution and argues that Johnson produces no evidence that there is an order of magnitude between micro- and macro-evolution. Moreover, if Johnson must stick to this distinction, can he provide any evidence of "animals popping into existence out of thin air?" Frymire, not surprisingly, is quite comfortable with the standard evolutionary model of common ancestry.

In similar fashion, Frymire gives breezy treatment to the problem of the fossil evidence, Behe's irreducible complexity, evidence in favor of human evolution, the question of the role of design in the light of the manifest suffering and violence in nature, and the so-called "moral prostitution argument" (that without God there is no adequate basis for morality). Throughout his brief chapters, Frymire draws from a fairly wide reading of many of the popular scientific works of Dawkins, Gould, Williams, Pinker, et al. But his case against design suffers from too much attention paid to some of Johnson's rhetorical ploys and not enough to the growing body of design literature. To be taken seriously, a critique like his demands a serious engagement with the relevant literature. Unfortunately, Frymire gives no evidence of having done the requisite homework.

Some of Frymire's concerns about design theory are certainly appropriate and have been made more forcefully elsewhere. The regrettable thing about *Impeaching Mere Creationism* is that Frymire makes some very strong claims without giving any evidence either in his text or in his idiosyncratic notes that he has basic familiarity with the major works of the design movement save for three books written by Phillip Johnson and Michael Behe's *Darwin's Black Box*. He gives no mention of Dembski, Meyer, Nelson, Wells, et al. Admittedly, *Impeaching Mere Creationism* is a popular treatment by a nonspecialist for a general audience. And while it may suit Frymire's generalist purposes to use only Johnson and a smattering of Behe, it certainly calls into serious question the value of his book. After all, how can an author of a book offering a critique of intelligent design theory claim that it "doesn't explain anything, doesn't predict anything, and is completely untestable" without at least having grappled with Dembski's "explanatory filter" that purportedly offers a means of detecting design based upon the criterion of "specified complexity?"

I am inclined to ask what prompted this book to be published in the first place. Frymire's answer would no doubt be that, as a concerned scientist and citizen, he simply needed to speak up and challenge Phillip Johnson. But, as he well knows, Pennock, Miller, and a host of others have already done so and, frankly, much better. Perhaps the most compelling reason for the book can be found on the publisher's homepage.

Reviewed by Donald A. Yerxa, Professor of History, Eastern Nazarene College, Quincy, MA 02170; Assistant Director, The Historical Society, Boston, MA 02215.

CREATION RECONSIDERED: Scientific, Biblical, and Theological Perspectives by James L. Hayward, ed. Roseville, CA: Association of Adventist Forums, 2000. 384 pages, contributor list, index. Paperback; $19.95. ISBN: 0967369401.

This book contains papers delivered at the Conference on Geology and the Biblical Record sponsored by the Association of Adventist Forums, August 7–11, 1985. The twenty contributors were Seventh-Day Adventist scholars and pastors, most with doctorate degrees from mostly non-Adventist universities. The academic disciplines represented by the contributors include physics, biology, geology, geochemistry, medicine, anthropology, history, and theology. Along with a few conservatives open to dialogue, the contributors gathered in West Yellowstone, Montana, to address a broad range of scientific and biblical issues focused on the geologic column.

The Association of Adventist Forums is an organization independent of the Seventh-Day Adventist (SDA) Church. Its members are, in the words of one contributor to this volume, "thoughtful, committed Adventists" who nevertheless have views at variance with those espoused by SDA officials. The SDA church, like many fundamentalist churches, is committed organizationally to a young earth, calendar day interpretation of Genesis 1–2. Most of the participants in the Conference found this position untenable on scientific grounds.

Approximately half of the twenty-seven papers deal with such scientific topics as the geologic column, plate tectonics, pleochroic halos and time, radiocarbon dating, amino acid dating of fossils, reefs and natural history, paleoclimatology, and the worldwide distribution of taxa and the implications of that pattern of distribution for natural history. The remaining papers deal with the biblical and theological implications of the evidence for an old earth, the inspiration and authority of the Scriptures, the writings of Ellen G. White (whom the SDA consider to be a prophet), the Adventist view of the Sabbath Day, the interpretation of the Genesis flood narrative, and the relationship between Genesis 1 and Genesis 2.

Much of the scientific material presented in this volume will be familiar to readers of *PSCF*. The Bible-science issues that thoughtful, committed Adventists struggle with are treated regularly in the pages of this journal as well as on the ASA listserve. Moreover, there is nothing groundbreaking here: after all, the conference was held over fifteen years ago! (It should be noted that almost all the authors updated their papers to include references to scholarly literature published since 1985.)

Most readers of *PSCF* will probably want to pass on this book, but it would be of interest to two classes of readers: those just beginning to struggle with the young earth/old earth issue, and those with an interest in the intellectual currents in contemporary Adventism. For the first class of readers, the essays present compelling scientific evidence for an old earth, evidence they need to consider well. The essays dealing with that evidence biblically and theologically are of mixed value. Several papers strive mightily to reconcile the writings of Ellen G. White with the scientific evidence, a matter of no importance outside SDA circles. Other papers contain exegesis and analysis that could have been written by non-Adventists; their range and quality is comparable to that appearing in *PSCF*. (I found the essay on the extent of the Genesis flood particularly good.) For the second class of readers, this book is a good introduction to the thinking and the strug-

gles of Adventists in the sciences. Many outside Adventism will recognize those struggles as akin to their own.

Reviewed by Robert Rogland, Covenant High School, Tacoma, WA 98465.

Philosophy & Theology

FIVE VIEWS ON APOLOGETICS by Steven B. Cowan, ed. Grand Rapids, MI: Zondervan Publishing House, 2000. 398 pages, indexes of Scripture, persons, and subjects. Paperback; $17.99. ISBN: 0310224764.

"Through much of the twentieth century, American evangelical apologists have been battling one another vigorously over apologetic method" writes John M. Frame (Westminster Theological Seminary in California, p. 358). This analysis identifies and critiques the problems in their five most popular apologetic systems. Each has an advocate's overview and critiques by the other four. The book, including ample footnote references, ends with each author's "Closing Remarks" and the editor's conclusions, so it is like a detailed debate report.

Classical Apologetics, presented and defended by William Lane Craig (Talbot School of Theology), emphasizes the role of reason in *showing* Christianity to be true, along with recognition that *knowing* it to be true is warranted by the inner work of the Holy Spirit in a person's life. *Evidential Apologetics* (Gary R. Habermas, Liberty University) appeals to objective facts in the world to warrant the conclusion that Christianity is true. It is a "one-step approach" that does not first try to prove that God exists. Paul D. Feinberg (Trinity Evangelical Divinity School) advocates *Cumulative Case Apologetics,* the "inference to the best explanation approach." Its emphasis is on the internal and external witness of the Holy Spirit as a source of certitude for the believer and of conviction for the unbeliever through tests for truth (consistency, correspondence with reality, comprehensiveness, simplicity, livability, fruitfulness, and conservation by providing the least radical world view shift). Frame's *Presuppositional Apologetics* argues that the fear of the Lord (reverent awe that yields obedience) is the ultimate criterion of truth. God's rationality is the source of human faith, which in turn is the source of human reasoning, since "we do legitimately believe most things without proof or argument" (p. 215). Thus, Scripture is primary to the apologetic tasks of proof (rational confirmation for faith), defense (replies to criticisms), and offense (criticizing non-Christian ideas). *Reformed Epistemology Apologetics* (Kelly James Clark, Calvin College) claims that positive arguments to defend Christianity are unnecessary for rational faith in God. All human beings have an innate sense of the divine, so the focus of apologetics is both negative (defensive) when challenges to theistic belief are encountered and positive, encouraging unbelievers to awaken their latent sense of the divine. Major tenets, methods, concepts, assumptions, strengths, and weaknesses of each system are presented and critiqued in considerable detail.

This book contributes significantly to reconciliation among advocates of the various apologetic methods and to recognition that they are less polarized than once believed. The authors agree that we need both positive reasons for Christian faith and negative defenses of it, that the classical arguments for God's existence and historical arguments for Christian faith are useful apologetic tools, that sin noetically influences negatively the ability and willingness of unbelievers to accept rational arguments for the faith, that the work of the Holy Spirit is crucial, that unbelievers share much epistemological common ground, and that postmodern relativism is an unwarranted self-defeating obstacle to doing apologetics. (Postmodernism is the subject of so many scattered critiques and comments that purchase is warranted for that alone.)

However, the apologists still differ about such topics as how to classify their methods, the role of the Bible in apologetic methodology, whether to invoke the concept of miracle to explain a historical event without first establishing that God exists, the importance of positive arguments in demonstrating the truth of Christianity, whether all world views are defended circularly, and if the resurrection of Christ is antecedently improbable.

These experts give Christians in the sciences many nuggets of truth. Besides an in-depth view of the complexities of arguments for the faith, they remind us that neutrality on any issue of truth and rationality is impossible, that neither logic nor reason is neutral, that absolute religious certainty cannot be obtained through reason on this side of the grave, that it is dangerous to believe simplistic views of either "the Bible only" or "reason only" will convince everyone to accept the faith, that all arguments are relative, and above all that the Bible provides no single apologetic system ("So let a thousand apologetical flowers bloom!" p. 275). Many strikingly perceptive sentences pop up, for example, "The selective and tendentious reading of Scripture by those who claim to be most sensitive to Scripture is curious indeed" (p. 371), and "It is not unusual for modern secularists to claim that all truth is relative while insisting that naturalistic evolution is a proven fact, never conscious of the contradiction into which they have fallen" (p. 212).

Scientists reciprocally help apologetics through contributions to natural theology (knowledge of God's self-revelation in and through nature). Hints of the apologists' need for the social sciences emerges on such topics as how people actually acquire beliefs (pp. 273, 304); the interaction of cognitive therapies with existential techniques in healing (p. 299); "what situations arouse beliefs that transcend evidential defeasibility" (p. 309), and which cultural differences make it easier or harder for people to accept the logical facts of God and his Word (p. 311).

Although "all the authors ... tried to write without presupposing that the reader is well-versed in philosophical jargon" (p. 21) and a four-page glossary of key concepts is provided, this book is mainly for people already well grounded in philosophical or theological apologetics, not the average *PSCF* reader. It is a sophisticated study of

apologetic systems, not a manual on how "ordinary Christians" can best defend and share their faith.

Reviewed by David O. Moberg, Marquette University Sociology Professor Emeritus, 7120 W. Dove Ct., Milwaukee, WI 53223.

GOD'S NAME IN VAIN: The Wrongs and Rights of Religion in America by Stephen L. Carter. New York: Basic Books, 2000. 248 pages, notes, index. Hardcover; $26.00. ISBN: 0465008860.

In this book, Carter, a professor of law at Yale, revisits the issues treated in his 1993 book, *The Culture of Disbelief*, and expands upon them. He focuses on the questions, how and when should persons take their arguments based on religious principle into the political arena. Carter is the author of many works in recent years, among them *Integrity and Civility*.

It is a rare author who writes in a way that makes you like him even when you disagree with his arguments. Carter does that. I fill each of his books in my library with marginal notes as I grapple with the issues he deems important. Carter writes with excellence; his discussions, while on a scholarly level, are seldom obscure. They are always thought provoking. He writes with passion and utter integrity. I highly recommend this book (and other Carter volumes) to my ASA colleagues.

Carter pursues two themes. The first is that arguments based on religious grounds (presumably from religious people) should be welcomed into the dialogue of American culture and not, as is done sometimes, marginalized. The second is that religious activists who enter the political arena must do so with considerable care so as not to "lose their souls." He enlarges upon these issues with examples from law and history. He writes from both theological and philosophical viewpoints, and includes utterances by both pro-slavery and anti-slavery preachers of the nineteenth century, and the anti-war and civil rights advocates of the twentieth. Persons who argue that church-state separation should keep religious people and arguments based on religious principles out of political discourse are, as Carter puts it, simply wrong. I find him very persuasive.

The chief weakness in *God's Name in Vain* is Carter's avoidance of the issue of factuality as he wrestles with arguments where religious views conflict with secular culture. In several places, he treats the religious view, held by a substantial number of American people, that the earth is very young. There is no evidence that Carter holds this belief himself, or even gives it any credence, indeed, he calls it "bad science" (see *The Culture of Disbelief*, p. 161). Yet, he avoids the discussion of the question "Does teaching it in classrooms in any significant way hurt the students?" On page 3, he writes: "... I am not sure why it is more 'fanatical' for parents to tell their children that the creation story in Genesis is literally true than for the public schools to tell the same children, required by law to attend, that the religion of their parents is literally false." It would seem to me that when a religion teaches something that is clearly factually untrue, such as a young earth, or a flat earth, or the supremacy of white people, the secular culture is obligated to teach otherwise. In a footnote, Carter makes much of a survey which shows that a significant number of our citizens do hold to the young earth position, but I fail to see how that particular fact holds any significance.

The book is divided into two quite different sections. The first, "Religion's Sphere," shows a number of very specific ways in which politics and religion necessarily interact. The second, "Religion's Voice," suggests a number of current political issues where religious arguments offer a potentially vital contribution. In the second section, Carter treats the important subject of "Measurism," the philosophical position that, if an attribute can be measured, even poorly measured, it is, *ipso facto*, of more importance than an attribute which does not admit to that characteristic. If you read nothing else from Carter—read this section, chapter 10, a brief twenty pages. It will be, I suggest, like eating the first peanut at a baseball game—you will likely finish the bag (book).

If you are an evangelical Christian, you will find much to agree with in this book. If you are a liberal Christian, you will find cogent arguments from the right, and find more areas of agreement than otherwise. To any secularist reading this review, you owe it to yourself to read this book to understand how your religious colleagues might view the issues.

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IS THE BIBLE TRUE? How Modern Debates and Discoveries Affirm the Essence of the Scriptures by Jeffrey L. Sheler. New York: Harpercollins, 1999. 288 pages. Hardcover; $24.00. ISBN: 0060675411.

Sheler is a religion writer at *U.S. News & World Report*. He has done a great service of making available at a popular level a good survey of the literature bearing on the Bible's general reliability—even if one may disagree with him on the details.

His book is divided into six parts. In Part I, "The Bible and History," he surveys the nature of the "battle for the Bible" since the Enlightenment and discusses the authorship and canonization of the biblical books. He notes that any divine involvement or "inspiration" need not preclude historical accuracy—no more than Herodotus' belief in the Delphic Oracle disqualifies him as a reliable source on Greek history (p. 44).

Part II, "The Bible and Archaeology," is probably the most valuable portion of the book. After tracing the relatively recent rise and advance of biblical archaeology, Sheler discusses key archaeological finds that have shown the Bible to be trustworthy at key points. For instance, the 1993 find of the inscription in upper Galilee of "the house

of David" on a *stele* (monument) dating to the ninth century BC brought the Davidic monarchy out of the realm of legend and into history.

Sheler reminds us that absence of archaeological evidence for, say, the patriarchs should not be surprising since the Bible speaks of "family stories" (in this instance) rather than "geopolitical history" (p. 73). But we do see repeated corroborations of the biblical record with secular history (such as inheritance laws or the pricing of slaves in the ancient Near East when diachronically analyzed). When we look for the evidence of an exodus out of Egypt, we obviously cannot expect to find a pharaoh mentioning the embarrassing flight of slaves out of the land under his control! We do, however, have significant corroboration: archaeological evidence for Hebrews (*Apiru*) in Egypt (e.g., their building projects) during a limited time period and then in Canaan afterwards—a remarkable fit with the Bible. Despite some gaps in the evidence, we have significant verification of the Canaanite conquest—even if potential data is limited (e.g., only three cities were recorded as having been burned: Jericho, Ai, and Hazor). The recent discovery of the Philistines (a people probably from Crete originally) and the evidence of their metallurgical prowess (see 1 Sam. 13:19) showed that the skeptical charge of "invention" was erroneous (p. 98). Corroborative evidence for Solomon's reign, for the Assyrian threat on Jerusalem during Hezekiah's reign (pp. 104-6), for Pontius Pilate, and for Jerusalem's topography and architecture as described in John's gospel—to give a sampling—offers us a solid historical core for the Bible.

The topic of Part III is the Dead Sea Scrolls—their discovery, the controversy and politics surrounding them, the various abuses of their interpretation (such as Barbara Thiering's secret-code approach), and their historical value (e.g., Josephus spoke of the Essenes in his writings). The Dead Sea Scrolls revealed the remarkable textual preservation of the Old Testament—as well as the existence of various editions of the Old Testament text during Jesus' time. It was also the discovery of these scrolls that has convinced scholars that John's Gospel is thoroughly Jewish—rather than Hellenistic—in its world view (pp. 166-8).

Part IV deals with "The Bible and the Historical Jesus." Sheler surveys the various Enlightenment-and-beyond "quests" (and the "non-quest") for the historical Jesus. He offers a helpful summary of particular contemporary "questers" such as Robert Funk, Marcus Borg, and John Dominic Crossan—all Jesus Seminar members—in addition to John Meier and N. T. Wright. Sheler examines some of the purported historical difficulties surrounding the birth of Jesus—such as the alleged pagan influence surrounding the virgin birth and the apparent conflicts between Matthew's and Luke's birth narratives—and sorts out the issues succinctly. Sheler then looks at Jesus Seminar-type criticisms surrounding the person/message of Jesus as well as his death and resurrection; upon closer inspection, the orthodox understanding of Jesus fares quite well.

Part V, "The Bible Code and Prophecy," is a bit of a detraction from the upshot of the book, but it is still a good introduction to the issue. In short, the "Bible code" (in which encoded messages within the Hebrew Old Testament text allegedly predict the 1991 Gulf War and the assassination of Yitzhak Rabin as well as the appearance of personages such as Hitler and Nixon) is sensationalistic and naïve. Similar "messages" have been detected by computer searches in the text of Melville's *Moby Dick*!

Sheler concludes that many questions about the Bible's historicity remain elusive, and he rightly does not assert more than he should when doing this type of historical analysis. But he urges the reader to consider that perhaps something transcendent might be moving biblical writers and shaping history in significant and salvifically meaningful ways.

I think the book has much to commend it. It is a fine conservative introduction on biblical criticism and an even-handed defense of biblical reliability from a number of different angles.

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UNAPOLOGETIC APOLOGETICS: Meeting the Challenges of Theological Studies by William A. Dembski and Jay Wesley Richards, eds. Downers Grove, IL: InterVarsity Press, 2001. 280 pages. Paperback; $19.99. ISBN: 0830815635.

This book grew out of a weekly seminar sponsored by the Charles Hodge Society, a student group at Princeton Theological Seminary dedicated to restoring classical Christian apologetics to theological education. The Charles Hodge Society aims to reclaim seminary education from the theological malaise gripping the mainline denominations by "inoculating" potential seminarians against the modernist and postmodernist concepts they will encounter in their studies. In the Society's view, a robust apologetic that confronts and answers those concepts is the best means available to evangelicals for maintaining their faith in a seminary hostile to their beliefs; indeed, not simply for maintaining their faith, but for contending for it.

Unapologetic Apologetics is divided into five parts. Part 1, "Foundations," includes essays dealing with the task of apologetics, the fallacy of contextualism, and the history of apologetics at Princeton Seminary. The task of apologetics is presented as the defense of the catholic faith of the Church, the stable, unchangeable core of Christian belief. That very conception of the Christian faith is challenged by *fallibilism*, the claim that the Bible itself as well as the theological reflection of the Church through the centuries, is inherently fallible. It is also challenged by *contextualism*, the claim that what is true and good is entirely determined by the context in which truth claims and ethical claims arose. Dembski, one of the editors and

the author of five of the fifteen essays in the book, devotes a whole chapter to refuting the logic of contextualism.

Part 2, "Scripture," deals with the problem of error in Scripture, with naturalism in theology and biblical studies, and with Old Princeton's doctrine of Scripture (i.e., the view that predominated at Princeton until its re-organization in 1930). It does not deal with specific alleged errors in Scripture, but looks at the matter more generally. Naturalism intrudes into theology and biblical studies at the seminary level in denying supernatural intervention, whether miracles or inspiration of the sacred text. Challenges to the orthodox view of authority and inspiration based on supposed errors in Scripture or stemming from naturalistic presuppositions are nothing new. Old Princetonians like Charles Hodge and B. B. Warfield had to answer the same challenges over a hundred years ago, and the third essay in this section holds up the Old Princetonian response as a model for today.

Part 3, "Christology," defends the orthodox doctrine of the Incarnation against charges of incoherency and against the claim of radical feminism that Christ, a male, *a priori* cannot be a savior for women.

Part 4, "Theology," contains an essay continuing the rebuttal of the feminist attack on orthodox Christian doctrine and defending the Bible against charges of sexism. A second essay asserts the adequacy of human language in talking about God, in particular, language viewed as sexist by feminists. It also contains an essay arguing against universalism, the unorthodox doctrine that Christ actually saved all human beings.

Part 5, "Science," contains two essays by William Dembski, whose work as a design theorist is probably known to most readers of *PSCF*. He argues not only against naturalistic evolution, but also against theistic evolution, at least as the latter is commonly understood. (Dembski sees theistic evolution as methodologically equivalent to naturalistic evolution; it is therefore unable to reply to the secularist who would cut out the theistic aspect with Ockham's Razor.) In his second essay, he describes his *explanatory filter*, a set of criteria for deciding if an entity or system is the product of random natural forces or intelligent design. Applying it to natural systems, especially biological systems, he concludes that the case for design is well founded. Part 5 also includes a chapter on the challenge of the human sciences to orthodox beliefs.

The appeal of this book for ASA members is probably limited, unless they are contemplating seminary or know someone who is. The essays by Dembski on Intelligent Design would be most interesting to scientists, but they summarize work he has published elsewhere; there is nothing new here. Conservative Presbyterians like myself might enjoy the historical material on Old Princeton, but that, too, is readily available in other works.

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THE CRAFT OF RELIGIOUS STUDIES by Jon R. Stone, ed. New York: Palgrave, 2000. xv + 235 pages, index. Paperback; $18.95. ISBN: 0312238878.

The fifteen autobiographical essays by distinguished scholars in various specialties center around methodological issues in the interdisciplinary field of religious studies. First published in hardcover editions (Great Britain: Macmillan, 1998; New York: St. Martin's Press, 1999), they strikingly reveal how personal life experiences during childhood, youth, and adulthood aroused and shaped spiritual quests. These in turn awakened questions and interests that became major stimuli for their intellectual journeys and careers centered around philosophical explorations, conceptual reflections, research investigations, theological adaptations, and theoretical innovations. For example, Jacob Neusner, whose 675-plus books make him the most published humanities scholar in the world, shares how self-doubt has influenced much of his career and made him his own harshest critic.

The conclusion of John Hick, an internationally esteemed philosopher of religion, that the relationship between world religions is one of the main problems facing Christian thought today (p. 90) is reflected throughout the book. Typical of most authors, he believes that "basic Christian theology ... [as] the most probable picture of reality" is an anachronistic throwback to medieval scholasticism that is "unrelated to the needs of the modern mind" and unable to succeed even in its own terms (p. 83).

Historian Martin E. Marty perceptively argues that "varying prejudgments or biases color the thinking of *everyone* in religious studies" (p. 158). [The same applies to everyone in any academic or scientific enterprise.] Although several authors are critical of rationalism, modernism, postmodernism, and even deconstructionism, they elevate abilities and accomplishments of the human mind above faith in the Creator divinely revealed through nature, the Judeo-Christian Scriptures, and especially Jesus as the Living Word of God (John 1:1–14). Yet even Hick's discussion of the incarnation of Jesus as only a metaphor acknowledges that none of his evidence against Jesus' deity shows the doctrine to be certainly false. It merely induces a "hermeneutic of suspicion" (p. 95), yet he joins "the modern re-understanding of Christianity as one valid context of human salvation among others" (p. 96).

Marty clearly explains that the guiding theoretical assumptions that reduce religion until it is "nothing but" this or that cannot be settled by a determination of whether something is or is not indeed there through either history or any other approach in religious studies. Even Hick, however, acknowledges that facing each problem acutely felt by religious persons is a successive venture like climbing a mountain range; whenever one reaches a summit, another higher mountain comes into view "with the awareness that only the foothills of truth have been reached" (p. 76).

Scientific methodology is reflected throughout these perceptive chapters, even though most, except for those

by sociologists Rodney Stark, Phillip Hammond, and Andrew Greeley, are grounded primarily in humanistic research. "Scientific knowledge springs from intuitions steeped in facts, sharpened by logic and continuously tested by both," writes Frits Staal, professor emeritus of philosophy and of South Asian studies, U. of California, Berkeley (p. 70). Thus, for example, Christian missionaries are often ethnocentric, but their reliable descriptions of indigenous cultures frequently are distorted by the [ethnocentric!] methodological requirements of "scientific anthropology." Staal recognizes that studying religion differs from studying the universe because people are a part of religion and therefore can never be completely objective. He also observes that the "insipid mediocrity which piety preserves is by no means peculiar to Buddhism" (p. 65).

Reading this collection by Editor Stone (Near Eastern Studies, U. of California, Berkeley) was a mind-spinning experience. It reminded me of numerous religion-related concepts and topics worthy of further study, as well as of key resources helpful in beginning their pursuit. (Quoting significant statements would consume an entire page.) It also increased my awareness that the academic field of Religious Studies is generally more unfriendly toward Christian faith commitment than to most other "particularistic" or "exclusivistic" religions. Most of its leading scholars have experienced a personal "theological trajectory" similar to that of James M. Robinson (Claremont Graduate University) who "moved step by step from right to left" (p. 121) under the impact of the "hidden apologetics" (Ivan Strenski, U. of California, Riverside, p. 309) of the discipline's dominant assumptions in biblical and other scholarship.

I have a hunch that the life-experience trajectories of theologically conservative religious studies scholars or of prominent persons in the huge biographical directory, *Who's Who in Theology and Science* (New York: Continuum, 1996), which includes only one of the authors (Marty), would point in quite different directions from those of most authors in this book.

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Letters

Eden and Noah

In her articles on Eden (*PSCF* 52, no. 1 [March 2000]: 31–46) and Noah (*PSCF* 53, no. 1 [March 2001]: 24–40), Carol Hill locates Eden in Mesopotamia, and identifies Noah as King Ziusudra of Shuruppak in Sumer (ca. 2900 B.C.). Hill makes her case very well, but there are some difficulties:

1. Taking "heads" in Gen. 2:10 to refer to estuaries goes against normal usage.

2. Ancient Hebrew did not distinguish between bronze and copper. Native copper and iron were worked much earlier than Hill dates Tubal-Cain.[1]

3. The flood from which King Zuisudra escaped lasted only about two weeks,[2] whereas Noah's lasted over a year.

4. Gen. 6–11 gives the impression that the Flood covered the ancient world, which Noah's family subsequently repopulated. However, there was no break in the history of Egypt around 2900 B.C.[3]

It may be possible to resolve these difficulties. If any readers can throw light on them, this would be helpful.

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[1]J. Mellaart, *The Neolithic of the Near East* (London: Thames and Hudson, 1975).
[2]J. B. Pritchard, ed., *Ancient Near Eastern Texts*, 2d ed. (Princeton: Princeton University Press, 1955).
[3]S. Quirke and J. Spencer, eds., *The British Museum Book of Ancient Egypt* (London: British Museum Press, 1992).

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Science has brought about enormou changes in our world. Christians have ofte reacted as though science threatened th very foundations of Christian faith. ASA' unique mission is to integrate and communi cate properly researched science and bibli cal theology in service to the Church and th scientific community. ASA members hav confidence that such integration is not onl possible but necessary to an adequate under standing of God and his creation. Our tota allegiance is to our Creator. We acknowl edge our debt to him for the whole natura order and for the development of science a a way of knowing that order in detail. W also acknowledge our debt to him for th Scriptures, which give us "the wisdom tha leads to salvation through faith in Jesu Christ." We believe that honest and ope study of God's dual revelation, in nature an in the Bible, must eventually lead to under standing of its inherent harmony.

The ASA is also committed to the equall important task of providing advice an direction to the Church and society in hov best to use the results of science and technol ogy while preserving the integrity of God' creation. An evangelical organization, th ASA provides a forum where scientists social scientists, philosophers, and theolo gians can interact together and help shap Christian views of science. The vision of th ASA is to have science and theology posi tively interacting and affecting one another

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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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Local Sections

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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