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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Putting Things Into Perspective

This issue offers a variety of themes, old and new, which frame current discussion of Christianity and science. The reader is invited to participate by composing a letter or through submitting a formal paper or shorter communication.

Scientist-philosopher Michael Polanyi has been a rich source of ideas for those who explore the frontiers of science and faith. J. W. Stines tackles the question of how chaos theory can challenge our thinking about time. His paper offers a dialogical biblical approach which he identifies in the thought of Polanyi.

David Siemens concludes his two part series on flood geology with a point-by-point case showing the folly of the "classical" deluvian view. The challenge to each member of the ASA is to communicate this message to that large segment of Christendom which continues to value such "Mosaic Geology" as religious and scientific orthodoxy.

Pseudogenes lurk in human cytochrome c proteins. These apparently nonfunctional anomalies pose questions for evolutionary mechanisms. Gordon C. Mills examines various interpretations of pseudogenes and the role of chance and intelligent design in the origin of genetic information.

In our first Communication, veterinarian Kenneth E. Kinnamon offers a Christian perspective on one aspect of the "animal rights" question. He argues for the continuing need to use animals in research and teaching as essential to "alleviating human injury, disease and grief."

Recent critical comments on evolution by law professor Philip Johnson and Philosopher Alvin Plantinga continue to stimulate discussion by our readers. Our second Communication deals with several issues related to Owen Gingerich's review of *Darwin on Trial* (*PSCF*, 44:2). John Wiester argues that author Johnson and reviewer Gingerich in fact hold similar views on the way that science functions, especially when observing and valuing anomalies. Next, Owen Gingerich offers further comment on *Darwin on Trial* and suggests that evangelicals should attack the atheists who use evolution to advance materialism, rather than seeking to disprove evolution.

Many theologians have sought answers to the "problem of evil." Karl Krienke applies A. E. Wilder-Smith's approach in evaluating the status of (so-called) "godless evolution." He argues that "God allows a system such as evolution to exist, free of the requirements of God's existence, as necessary in order to preserve the purpose of creation, free choice and true love."

Dialogue features Alvin Plantinga's response to William Hasker's "Evolution and Alvin Plantinga," which appeared in the September 1992 issue. In the course of reaffirming his position Plantinga challenges Christian biologists to examine evolution "unbuffaloed by all those claims of certainty trumpeted by the scientific establishment, and undaunted by the opprobrium visited upon those who dare to dissent." William Hasker will reply in our next issue.

We note the death of evangelical scholar Bernard Ramm, a long-time ASA member and active participant in science-Christianity discussions. His enduring interest is evidenced in Alton Everest's report that the day before Ramm's death in mid August, Everest received from Ramm in the mail a copy of John R. Albright's "God and the Pattern of Nature: A Physicist Considers Cosmology" (July 29, 1992, *The Christian Century*).

J. W. Haas, Jr.

Time, Chaos Theory and the Thought of Michael Polanyi

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Chaos theory is only recently breaking into the consciousness of the philosophical and scientific communities on a large scale; hence, exploration of its philosophical and theological implications has barely begun. This paper undertakes to sketch some key aspects of chaos theory, especially in relation to the notion of temporality, and to suggest that the import of chaos theory for our way of thinking about time calls for a dialogical biblical way of modeling it — such as is richly implicit in the works of Michael Polanyi — rather than the classical tragic way which has dominated traditional science.

Change and Continuity

If a speaker should suddenly interrupt his or her address and run amok among the audience, crawling on all fours, barking and biting at people's heels, he would create a great deal of *angst* — perhaps a feeling in the pit of the stomach that there is an abyss underfoot of which such apparent insanity is only a token. We tend to be made alternatively curious and anxious by anomalous phenomena and tend to believe, even if such strange behavior did occur, that it is not *really* anomalous, but an outcome of certain conditions which, had we been privy to them, would have made it predictable. That is, there is an almost overwhelming classical rationalist and classical tragic tendency in us. A part of us cannot imagine any particular moment in time as having meaning or as being psychologically bearable except insofar as it is finally viewed as subordinated to, and a manifestation of, structure and continuity. The alternative seems to be irrationality — cognate to chaos, cognate to meaninglessness.

When, in Sophocles' *Oedipus Rex*, the power and the very ground of predictability seem, momentarily, to have been falsified by the out-standingness of Oedipus — his apparent escape from his place of destiny and the predictions of the Delphic oracle — Jocasta says, half in relief and half in despair: "How can a man have scruples when it's only chance that's king? There's nothing certain, nothing preordained; it's best to live by chance as best we may."[1] But, of course, this sense of Oedipus' exceptionality is only momentary; and in the end there is relief in the realization that there is no suspension of the order which makes prediction possible and justice itself a reality. Spring will follow winter. Time, after all, to paraphrase Plato, is simply the moving representation of the universal, the eternal and unchanging.

However, there is another dimension to our humanity which is more deeply resonant with Oedipus in his moment of exceptionality and which chafes under the subordination of the apparently novel and particular to the universal. It is that side of us which is manifest in the sense of the personal; it protests on behalf of the reality and the uniqueness of every person as such and is outraged by their subordination to the abstractions of timeless structure. All of us know that it is a personal insult to have someone look out of the corners of their eyes and say, "Humph! I know you." We are inclined to respond by showing just how unpredictable or unknowable we really can be. However, we don't really know what to do with this sensibility, since "true" *scientia*

seems to render it illusory. The reality of the individual moment in time seems, *as such*, to be as intolerable and paradoxical as the phrase "chaos science." Correlatively, we have forgotten or denigrated the underpinnings of this sensibility in the Judeo-Christian tributary to our imaginations. In the Enlightenment tradition we asked whether Athens and Jerusalem have anything to do with each other. Both explicitly and implicitly we answered, at least intellectually and academically, in the negative, by coming down on the side of Athens, the side of the predominance of structure and necessity and, correlatively, on the side of objectivity and the dominance of the visual metaphor for describing our situation in knowing and being.

The Greek word *theoreo* meant "to look at," "to view," "to build," and "to know." That is, knowing in the classical rationalist context was affiliated with seeing in the sense of spectating. Reality is observed; it is given independently of the participation of the observer, the theoretician. To use a phrase of W.H. Poteat's, it is imagable as a series of closed "slices of dead space."[2] The real is pure form; and to no spectator or re-presenter of it would it occur to include, if you will, wild hairs, bulbous flesh, individual electrons, turbulence, implications of decay, a-rhythmia, passion or, in the language of chaos theory, "strange attractors," unless, perhaps, by a Platonic move to show their subjugation to a super order.

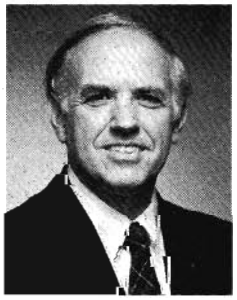
In ancient Israel there was a strikingly different mythos or paradigm of the real and the relation between change and continuity. Here was the sensibility that reality is intractable to mere seeing. No visual or purely theoretical relation to it is adequate or finally appropriate. It is not *necessity* which reigns, but contingency. The present is a real presence which might have been otherwise, since it is not a re-presentation of a timeless, mute, impersonal structure and necessitated by it. Human beings with proper names, in their concrete embodiment in time, stand in a dialogical relationship to and with reality. The dominant metaphor is oral-aural and timeful rather than visual-spatial. Correlatively, there is no history-nature or knower-known dichotomy, but an indissoluble dialectical relatedness. (It turns out that even God responds to human response.)

Now I take it that this sensibility is a bit like that dialectical situation which, to those physicists who are inveterate Athenians, is one of the implicit horrors of the Copenhagen interpretation of quantum indeterminacy. The *what* question cannot be separated from the *how* question. Knowledge as mere seeing or detached spectation is systematically elusive. The knowing subject in his or her historical contingency is a participant. He has to address nature in some particular way or "speak" to her, if you will, in order to get her to disclose herself. And how she answers is not independent of how she is addressed.

For biblical thought, both monotony and novelty, both continuity and change are seen as aspects of God's sovereign (hence uncoerced or unnecessitated) will in relation to his creation.[3] Predictability and order are but the outward manifestations, not of an a priori necessity, but of God's faithfulness; "yet he is choosing to be faithful anew, in every moment, with the result that there is real novelty both in the orderly and outside it."[4]

The apparently novel may be really novel in the way every one of an individual's acts — as action in distinction from mere reaction — is novel. "But at the same time it need not be meaningless because irrational, i.e., form-defying."[5] For however erratic may seem the act of a person whom you deeply trust, "however defiant of your power to put it into a finite and hence comprehensible context of interpretation, it may nevertheless be meaningful to the infinite context open to faith" and full participation in the personal dialogue.[6]

Recall Job's miserable and utterly baffling condition — so baffling that Job's wife, in full rebellion,



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says "Curse God, and die." Job, in effect, answers her that, "Though he slay me, yet will I serve him." The novel, unpredicted act of will cannot always be known to be rationally related to the stable purposes of that willing person. But it need not for that reason have no relation whatever when we grasp the act as proceeding from the will of a person we trust profoundly.[7]

Hopefully, personal quarrels with theism will not obscure the force of the analogies at issue here. Surely this latter way of modelling change and continuity is not, at its core, any more insane than the Athenian way; and it has the merit of being closer to our concrete personal experience, which affirms both the significance of particulars and of time as such and of continuity.

Chaos Theory: Non-Linearity

Now what, if anything, has all of this to do with chaos theory? If what I take to be a major import of chaos theory is correct, it may force a revolution — perhaps wider in scope than quantum theory — in the fundamental metaphors which govern our thought about rationality and knowledge in relation to change and continuity. Some of the reported phenomena underlying chaos theory were met, initially, with complete incredulity; however, it presently appears that chaos theory will stand alongside relativity and quantum theory as a major moment in twentieth century science. We have opportunity here to point to only a few paradigms and some of their apparent implications.

At the outset we can say that, in light of chaos theory, systems "ain't what they used to be." At the heart of the traditional perspective on systems (Godel's theorem notwithstanding) is the notion of continuity. A clock is a system, indeed a kind of system of all systems, insofar as it provides a picture of regularity itself which is a direct reflection of the determinism or continuity of physical law. Understand the laws of nature, the regularities, and you understand the universe, which is then itself a kind of clock whose movements, in principle, must be fully determined from "behind" and thus predictable. We recall the famous LaPlacean claim that if a supreme intelligence could see completely into the world system for just one slice of time, it could embrace in one formula all of the past and all of the future. In short, nothing can come out of a system so conceived which isn't aboriginally or timelessly, universally and predictably, in it. Several major aspects of chaos theory seem to cut squarely across this vision. The life of the electron apparently contradicts it at the micro level; but chaos phenomena do so at all levels.

In the new sense chaos may be said to be "orderly disorder created by simple processes."

Now it is important at the outset to disaffect ourselves of the tendency to equate "chaos," as used in the present context, with mere noise or meaninglessness. Some people in this field of studies are loathe to use the term "chaos" because of this tendency. But there is probably no single definition of the field that is a happy one for all of its explorers. In the new sense chaos may be said to be "orderly disorder created by simple processes."[8] Part of the import of this is that the simple linear relation implied by "If A, then B" has been subverted by our discovery that in many cases initial determining conditions may have complex and unpredictable consequences so that, though given A, we know not what the consequences except in very broad terms. Roderick Jenson, a theoretical physicist at Yale working on chaos theory in relation to quantum phenomena says that chaos theory is focused on "the irregular, unpredictable behavior of deterministic non-linear dynamical systems."[9] The so-called "chaos cabal" at the University of California at Santa Cruz was attracted, as Doyne Farmer, a physicist, put it, to the notion that you could have determinism but "not really." Farmer said:

> The idea that all these classical deterministic systems we'd learned about could generate randomness was intriguing .... You can't appreciate the kind of revelation that is unless you've been brainwashed by six or seven years of a typical physics curriculum. You're taught that there are classical models where things are determined by initial conditions, and then there are quantum mechanical models where things are determined but you have to contend with a limit on how much initial information you can gather. *Nonlinear* was a word that you only encountered in the back of the book. A physics student would take a math course and the last chapter would be on nonlinear equations. You would usually skip that, and, if you didn't, all they would do is take these nonlinear equations and reduce them to linear equations, so you just get approximate solutions anyway. . . . We had no concept of the difference that nonlinearity makes in a model. The idea that an equation could bounce around in an apparently random way — that was pretty exciting. You would say, "Where is this random motion coming from? I don't see it in the equations." It seemed like something for nothing, or something out of nothing.[10]

As chaos phenomena emerged as the focus of attention there was both dismay and enchantment. Why hadn't this been part of what we were taught?

Norman Packard, another member of the Santa Cruz group, said:

> It was striking to us that if you take regular physical systems which have been analyzed to death in classical physics, but you take one little step away in parameter space, you end up with something to which all of this huge body of analysis does not apply.
>
> The phenomenon of chaos could have been discovered long, long ago. It wasn't, in part because this huge body of work on the dynamics of regular motion didn't lead in that direction. But if you just look, there it is.[11]

What this "it" is that is there "if we just look" is almost as richly present as the concrete non-idealized everyday world in which we exist — a world alive with turbulence. The story is told that Werner Heisenberg said that on his deathbed he would have two questions for God: Why relativity and why turbulence? And Heisenberg says, "I think he may have an answer to the first question."[12]

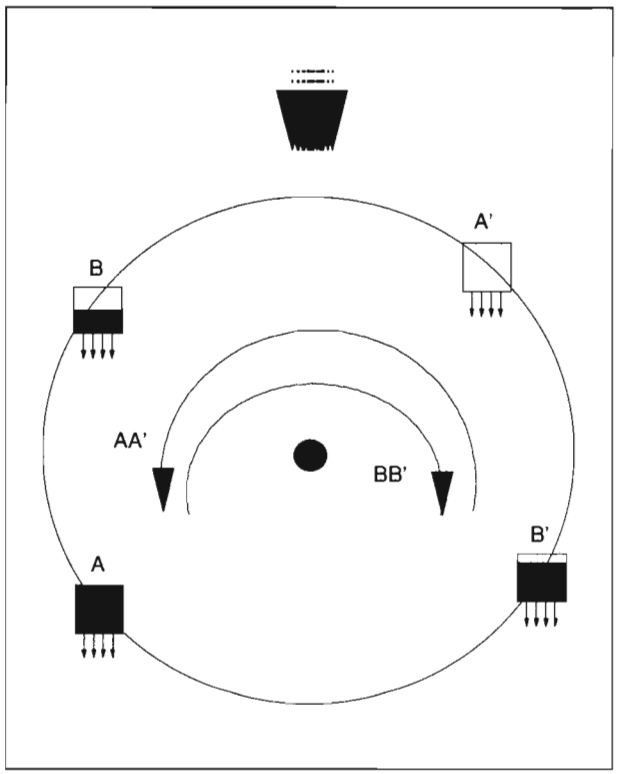


Figure 1: Lorenzian Waterwheel. *The line drawing above represents a steady flow of water (top) to an actual water wheel, depicted in steady (A) configurations or chaotic (B) configurations.*

Classical illustrations of some of the phenomena at issue in chaos theory are to be found in Edward Lorenz's waterwheel and in the Mandelbrot set. In the early sixties, Edward Lorenz, a research meteorologist at M.I.T., accidentally discovered what has come to be called "The Butterfly Effect" or what is referred to in more technical jargon as "sensitive dependence on initial conditions" — the realization that incredible richness and unpredictability can emerge from simple initial determining conditions. Lorenz turned aside from weather prediction to look for simpler ways to produce the complex behavior he had discovered there. He discovered a way in three non-linear equations. Those equations correspond perfectly to a simple mechanism which came to be known as the Lorenzian Waterwheel.[13] (See Figure 1.)

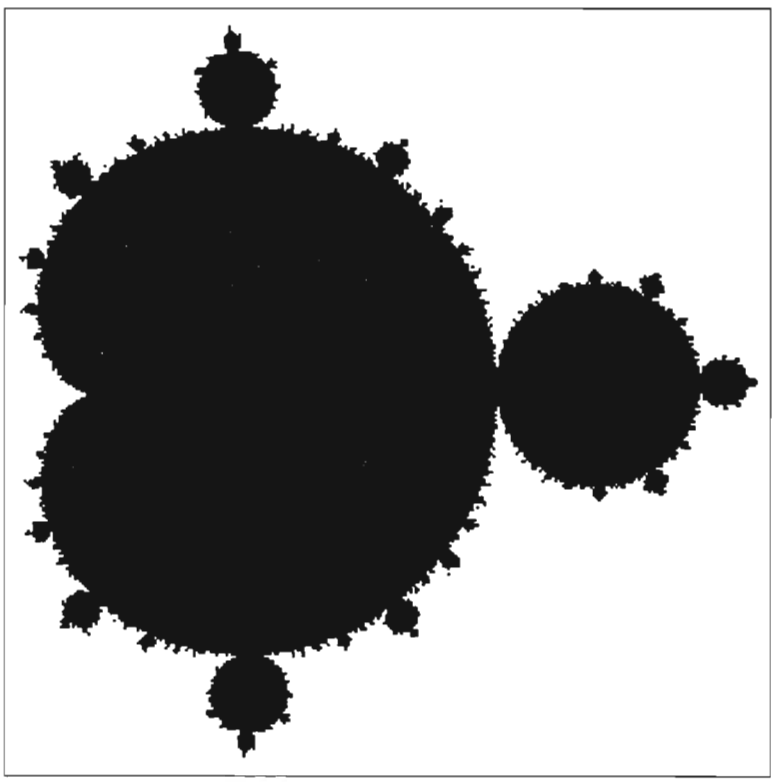
The water enters from the top at a steady state. If the flow is too slow the friction of the wheel is not overcome, and it never starts turning. When the speed of flow is increased the wheel is set in motion and can continue in motion at a steady rate with buckets filling (A) and emptying (A') rhythmically. However, if the flow is made still more rapid the spin becomes chaotic. Some of the buckets fail to fill (B) and some fail to empty (B').

> As buckets pass under the flowing water, how much they fill depends upon the speed of spin. If the wheel is spinning rapidly, the buckets have little time to fill up. . . . Also if the wheel is spinning rapidly, buckets can start up the other side before they have time to empty. As a result, heavy buckets on the side moving upward can cause the spin to slow down and then reverse.[14]

Lorenz found that over time the spin can reverse itself many times without ever settling down to a steady state or repeating itself in any predictable pattern. A kind of inveterate "common sense" about such a simple system would tell us that if the stream of water never varied, a steady state would evolve. "Either the wheel would rotate steadily or it would oscillate steadily back and forth, turning first in one direction and then the other at constant intervals."[15] But it doesn't. The map, correlated to the three equations, with three variables which describe the system, displays endless complexity. It stays within certain bounds but never repeats itself and traces a "kind of double spiral in three dimensions, like a butterfly with its two wings."[16] No point or pattern of points ever recurs — hence, a kind of orderly, pure disorder. The image of the spiral became known as the *Lorenz attractor*, an instance of the sort of phenomena later designated "strange attractors." Lorenz's paper on the equations was entitled "Deterministic Non-

periodic Flow" and was a definitive moment in the emergence of chaos theory. The waterwheel phenomenon was seen in important aspects to be analogous to properties of rotating cylinders of fluid in the process of convection. A colleague of Lorenz at M.I.T. was a professor of applied mathematics, Willem Malkus. Confronted with Lorenz's claims, Malkus laughed and said, "Ed, we know — we know very well — that fluid convection doesn't do that at all. The complexity would be damped out and the system would settle into a steady regular motion." Years later Malkus built a Lorenzian waterwheel for his own basement laboratory to show non-believers. He said of early responses to Lorenz's findings, "Of course, we completely missed the point. Ed wasn't thinking in terms of our physics at all."[17]

Another paradigm is the Mandelbrot set. It is, in effect, a program, a formula for generating chaos — another kind of picture of non-linear determinism. It involves an iterative process in which a number is put into an equation, and the resultant number is plowed back into it in an indefinite series of iterations. Without presuming to go into the equation itself we can note that the result of its iterations, graphically depicted on a computer screen (a work undertaken by mathematician John Hubbard), is full of incredible complexity and surprise. Mandelbrot had fathered the notion of shapes which are expressions of fractional dimensions and called them "fractals." He believed that the recursiveness of fractals reflects something that takes place in the complexity of everything from clouds, to shorelines, to treescapes.



One computer-generated representation of the Mandelbrot set.

However, when the Mandelbrot set was explored by increasingly powerful computers and examined under increasingly powerful magnification, what emerged were boundaries which were fractal, but not merely recursive. If boundaries between shapes and scale and period spaces were merely fractal recursive, then one iteration of the Mandelbrot set should look more or less like the last. The recursiveness of fractals, the "self-similarity at different scales" would, in theory, make it possible to predict what the electron microscope would see at the next level of magnification. However, each exploration deeper into the Mandelbrot set brought new surprises. "The set did prove to contain, when magnified enough, rough copies of itself, tiny buglike objects floating off from the main body; but greater magnification showed that none of these molecules exactly matched any other. There were always new kinds of sea horses, new curling hot house species. In fact, no part of the set exactly resembles any other part, of *any* magnification."[18] New molecules were surrounded by their own configuration and so on and on — new worlds, always similar, but never identical, seemingly marching to some sort of "mandate for infinite variety," predictable yet unpredictable.

A corollary of these and cognate developments — especially important as scientists moved from the Mandelbrot set itself to the problems of its relation to non-artificed physical phenomena — had been the emergence of the idea of the "strange attractor." Unlike the attractors of two dimensional phase space in which complete knowledge of a dynamical system can be extracted from a single instant in time, rendering the system representable as a single point, the so-called strange attractor (the insight of physicist, David Reuelle, and mathematician, Floris Takens) was a way of envisioning a kind of order in turbulence. Could there be an attractor correlated to non-periodic, never-repetitive behavior? Geometrically stated, the problem was what kind of orbit could be drawn in a limited space so that it would never repeat or cross itself and which would produce

an infinitely long line in a finite area. Interestingly, such a line would have to be fractal; however, at the time Reuelle and Takens claimed to have shown mathematically that such a line must exist, the notion of fractals had not yet emerged.[19]

But the concept of strange attractors and their presence in nature, their predictable unpredictability and novelty and their emergence at the boundaries of dynamical systems has become an important aspect of chaos theory. Their presence is related to new sensibilities about the difference in chaos and noise in their relation to information. The unpredictable spin-off of a system nested in the complexity and turbulence of our everyday world is not, as it were, "evil," that is, extraneous noise or static, but information fraught in its turn with apparently endless implications. At the heart of the so-called "butterfly effect" is the sense that every moment and every "turn" of a fractal is radically timeful in the sense that it is portentous with unforeseeable and inexhaustible import.

For Polanyi, just as we know more than we can tell, we also tell more than, in any explicit sense, we know.

William Shakespeare, with characteristic, almost numbing insight, has come close to summarizing a whole range of the issues here when, in *Julius Caesar* (III:3), he has Brutus say: "There is a tide in the affairs of men which, taken at the flood, leads on to fortune. Omitted, all the voyage of life is bound in shallows and misery. On such a full sea are we now afloat. And we must take the current when it serves or lose our ventures." It would appear now, not only from the biblical imagery, but from this new frontier in science, that some times, disanalogously to the rhythmic times of the ebb and flow of the ocean's tides, are a-rhythmic and, as such, far from being meaningless, they hold great promise. But because they are a-rhythmic they bespeak the essential nature of the particular moment in time as bearing within it a kind of now-or-never decisiveness which, in turn, bespeaks infinite possibility. It seems in the very nature of nature and history, as it were, to "sin boldly" — that is, to take risks and ventures and to live, if *live* they do, by grace, which is to say freely, but not thereby meaninglessly; or meaningfully, but not thereby deterministically.

Michael Polanyi and Non-Linearity

In light of these fairly recent developments Michael Polanyi's work seems strikingly prescient.[20] For Polanyi, just as we know more than we can tell, we also tell more than, in any explicit sense, we know. The telling to which we are heirs has set the stage upon which we receive our calling. However, what subsequently occurs upon the stage is not the theatrics of play-acting in which the lines have already been written, but action in that very sense without which we could not make any radical distinction between a John Gielgud playing Shakespeare's *Hamlet* and a John Kennedy acting the role of the president of the U.S.A. Our telling, in contrast to mere parroting, has as its conditions semantic dimensions which point beyond the explicit apparatus of the utterance both to the embodied speaker and to meanings, or if you will, to "strange attractors," which have been evoked and which evoke our being and our response, in a non-linear way. Polanyi's notion of "gradients of meaning" sloping in the direction of more stable configurations and, in a non-deterministic way, evoking our response, anticipates, but is enriched by, chaos theory's strange attractors and non-linear determinism.

For Polanyi, the ontological correlation of tacit knowing

> . . . consists not only in the fact that the known reflects the structure of knowing, but in the fact that it corresponds with knowing in a dialectical sense. Whatever is accredited as being real and/or true is, as such, embodied by the knower and the knowing process itself. . . . The truth becomes ever more "atoned," "attuned," "at one with," the way; ontology becomes epistemology. Epistemology expresses ontology.[21]

But the correspondence here is not the traditional, and therefore, perhaps the more obvious one in terms of which new accumulations of information simply become the objective factual foundation for an explicit and linear, deterministic process of inference making. "Rather, truth, incorporated and lived by the subject, takes on a life of its own and, accordingly, gains in its unspecifiable powers, insofar as it wholly outstrips any explicit control or deliberate manipulations."[22] And at any given level of organization or comprehension the boundary conditions — though presupposing the earlier levels of integration — are left open by them.

This is Polanyi; however, here chaos theory is remarkably anticipated; and chaos theory extends and verifies what is implicit here. The feedback and iteration which chaotically generate order, which is

then indwelled by the knower — or, which, in ontological terms, is subordinated to a new level of emergence — is a model of the non-linear way of emergence. Novel boundary conditions emerge in a non-linear and non-explicitable way in dialectic with prior conditions. No mere specification of subsidiary components and the laws which govern them explains or necessitates the comprehensive principle which subsumes them. The model of calling and evocation to which Polanyi had recourse receives reinforcement here; for clearly our acts of accrediting and placing at our disposal (indwelling) are functions of a sense of something being achieved which is irreducible to potential energy and specifiable deterministic processes. The movement toward new levels of integrations, epistemologically and ontologically, is clearly not as by necessity or destiny, but as by vocation, whose corollary is contingency.

As with the interpretation of quantum indeterminacy, arguments will persist as to whether the indeterminacy of so-called chaotic phenomena is ontological or only the result of momentary epistemological limitations. Indeed, some writers on chaos theory seem caught in this dilemma because they remain trapped in the very subject-object, mind-body dichotomy which Polanyi so effectively undermines. Chaos theory will also disarm this incredibly persistent mental set as we unpack the implications of quantum theory and chaos and of both to a theory of the "mindbody"[23] in its iterative, creative reflexivity and creative dialectical relation to "world." If someone wishes to say — in the vein of Einstein's response to Bohr and quantum theory — that the Lord God doesn't throw dice, that "nevertheless!" the consequent really and always is in the antecedent even if we can't predict it, one would want to say that this is Cartesian gnosticism; it is metaphysics in the vicious sense. Here language has gone on holiday.[24]

Moreover, if the present does not *entail* the future and yet the future does not obtain without the present and the past, we must say not that the latter "causes" the former, but that the latter is contingently related to the former. That this way of speaking seems so unsatisfactory — no "explanation" at all — is due in large measure to the continuing presumption to explanation by way of recourse to the visual. We cannot visualize contingency for it is not a "thing" and is, therefore, elusive to visualization. Correlatively, we cannot create a graven image of time. We hear it and live it as it clings to us, but we cannot spectate it. In time it is no more the past which occasions the future than the future which occasions the past. The future bears down upon the present to create a new presence. The iterative relations of past and future generate chaos. They manifest real presence, the action of creation.

If there is time in this sense and if, therefore, we cannot "explain" the future from the past, then perhaps this is due to an energy or anti-entropy which ruptures any closure into the classical "pure" system, constantly relativizing it and giving "system" and time meaning.[25] Polanyi, as we know, said unequivocally, "I do not believe the universe is meaningless."[26] Wittgenstein said (in the *Tractatus*) that if there is any meaning to the world, it must lie outside the world. Perhaps this is so. But perhaps we should go on to say that meaning comes to us at the boundary, continually and freely changing it, though not in the manner of a meaningless, alien freedom which is in no way responsive to our own and to our history — but perhaps in the manner of "chaos" as used here. The root analogy, I submit, is that of a dialogue leading us to unimaginable futures. It is this dialectical Judeo-Christian sensibility and fidelity to his own experience which emboldened Polanyi to write a book entitled *Personal Knowledge.* ☆

NOTES

1 Roche, Paul, (trans.) 1958. *The Oedipus Plays of Sophocles*, New York: New American Library.

2 Poteat, W.H. 1985. *Polanyian Meditations: In Search of a Post-Critical Logic*, Durham: Duke University Press, p. 66. It should be noted that Poteat mounts a decisive critique of the notion that vision is timeless and "objective." However, the tradition, having obscured the phenomenon, has assumed that the "moment" of vision is without "temporal thickness."

3 See Poteat, W.H., 1956. "Tragedy and Freedom," *The Carolina Quarterly*, vol. VIII, p. 2. This paragraph is paraphrase and interpretation based on this article.

4 *Ibid.*

5 *Ibid.*

6 *Ibid.*

7 *Ibid.*

8 Gleick, James, 1987. *Chaos: Making a New Science*, p. 266. New York: Penguin Books. The following description of developments of chaos theory is everywhere indebted to Gleick's volume. See in addition: Paul Davies, 1988. *The Cosmic Blueprint: New Discoveries in Nature's Ability to Order the Universe*, New York: Simon and Schuster. For a more technical treatment of the subject see: Mandelbrot, Benoit, 1983. *The Fractal Geometry of Nature*, New York: W.F. Freeman and Co.; Thompson, J.M.O. and Steward, H.B., 1986. *Nonlinear Dynamics and Chaos: Geometrical Methods for Engineers and Scientists*, Chichester: John Wiley and Sons.

9 *Ibid.*, p. 306.

10 *Ibid.*, p. 250-251.

11 *Ibid.*, p. 251.

12 *Ibid.*, p. 121.

13 Figure 1 is adapted from A.E. Brotman's illustration. *Ibid.*, p. 27.

14 *Ibid.*, p. 27.

15 *Ibid.*, p. 30.

16 *Ibid.*, p. 30.

17 *Ibid.*, p. 31.

18 *Ibid.*, p. 228.

19 *Ibid.*, p. 139.

[20] The reader who is unfamiliar with the works of Michael Polanyi is referred especially to *Personal Knowledge: Towards a Post-Critical Philosophy*, Chicago: University of Chicago Press, 1958; *The Tacit Dimension*, Garden City, N.Y.: Doubleday; and *Meaning* (with Harry Prosch), Chicago: University of Chicago Press, 1975. Polanyi's work was the focus of the March 1982 issue of *Zygon: Journal of Religion and Science*. (p. 17.)

[21] Stines, J.W., 1985. "I Am the Way: Michael Polanyi's Taoism," *Zygon: Journal of Religion and Science*, vol. 20 (March), p. 66-67.

[22] *Ibid.*, p. 67.

[23] Poteat, W.H., 1985. *Polanyian Meditations: In Search of a Post-Critical Logic*, Durham: Duke University Press. In this and in subsequent works, Poteat has coined the term "mindbody" and given it force in his radical foray at undermining our persistent Cartesian dualism.

[24] Thomas Torrence has observed that this interpretation of Einstein is a widely-held misapprehension of Einstein's meaning here since Einstein clearly saw space-time relativity as undermining traditional views of causal connections. Clearly, that is important to note; however, it is the widely held misapprehension which is the relevant point here.

[25] The "anti-entropy" mentioned here is meant to suggest a freedom and/or transcendence which lies at the boundary of the "world" of the second law and its closure. It is a suggestion which is correlative to Kant's understanding of "world" as a limiting concept and to Wittgenstein's concept of the meaning of the world (if there is any) as lying outside the world. This does not mean that, for instance, somewhere within the world there is a perpetual motion machine. Surely, it is true to say that *within* the "world" of the second law there cannot be any relativizing "energy."

In addition (a different point) it seems entirely legitimate to raise a question about the sense in which laws may be said to continue to "hold" if the particular phenomena which they are presumed to cover are intractable to their predictive power. In certain respects, such laws seem to hold only in the Procrustean way linear reductions held for non-linear equations. They may well have powerful uses, but their philosophical import becomes more equivocal as the limitation on our knowledge of their future manifestations becomes more severe.

[26] Polanyi, Michael, 1958. *Personal Knowledge*, p. 286. Chicago: University of Chicago Press.

More Problems With Flood Geology

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The view that the Genesis Flood totally revamped the prediluvian world has its proponents contradicting themselves. Their claim that modern mountain ranges arose only after the Flood is in conflict both with common sense and with scientific observations of mountain building. Their theories of the state of the earth before the flood, with an atmospheric "canopy" and a subterranean "great deep," are implausible. Their mechanism for the Flood would produce earthquakes and tsunamis, or even a free fall, that the ark would not survive. As its proponents present it, "Flood Geology" is clearly unacceptable.

In a previous paper, I noted several problems with "Flood Geology" (diluvianism) that should not take special expertise in any of the sciences to understand.[1] For example, I noted that Henry Morris, a prominent diluvianist, claimed both that terrestrial life survived and did not survive outside the ark. He also contradicts himself concerning the flood waters. In one passage he writes:

> Even if only the mountains in the immediate vicinity of the mountains of Ararat on which the ark grounded when the waters began to recede ... were covered, it would not have been possible for the flood waters to be retained in the local vicinity. The present Mount Ararat is seventeen thousand feet high, and it was two-and-a-half months after the ark grounded before the tops of *any* mountains could even be seen. It was an additional 4½ months before the water level went down enough to let the occupants leave the ark. To imagine that a year-long, seventeen-thousand-foot high flood could have been a *local* flood is absurd.[2]

Whereas elsewhere he writes:

> The Bible does tell us that one of the most important questions of geophysics—that is, the question of orogeny, of how and when the mountains were formed — must be answered specifically in terms of the great Flood. There were, of course, mountains in the originally created world, but they were relatively low and of gentle slope, not the rugged, uninhabitable ridges of the present world. The waters of the Flood covered these mountains to at least 15 cubits ... Once the antediluvian topography had been leveled by the devastating flood waters, however, and the world completely inundated, then great mountain uplifts began to take place. ... Thus, the present mountain ranges of the world were formed during and following the Flood.
>
> The great mountain uplifts, and corresponding ocean basins, would necessarily be accompanied by an abundance of other tectonic activities—faults, folds, thrusts, and earth movements of many kinds.[3]

Somehow, the waters rise to 17,000 feet (over 5 kilometers) above mean sea level when the universality of the Flood is noted, and a fraction of that when a theory of mountain building is invoked. In the real world, water cannot be nearly 5182 meters deep when the entire terrestrial water supply can cover a smooth globe only by about 2950 meters (9,700 feet), a figure Morris himself notes.[4] Since he rejects the theory that water was miraculously created and then miraculously removed, that option cannot be called in to explain the difference.[5]

Diluvianist Orogeny: Soft Soils and Hard Shakes

If we pass over this contradiction, the crucial element in this diluvianist view appears to be that the rise of mountains is strictly a postdiluvial phenomenon. John C. Whitcomb claims that "suddenly,

This article is the second in a series of two by the author on this subject.

just after the Flood," the continents and mountains rose.[6] Morris makes the rise relatively rapid. But "the transition period ... probably lasted many centuries."[7] A major problem arises if one tries to raise recently deposited material to form mountains. Sand, silt and clay, saturated with water, ooze and run.[8] For example, we do not need breaking waves to batter sand castles flat. As soon as the flow wets their base, they collapse.

The simple problem of making mud pile up thousands of feet is complicated by the earthquakes that always accompany any faulting that elevates ground. A recent search produced records and estimates for over thirty earthquakes where a relative change in elevation was recorded.[9] (See Table 1.) These are graphed in Figure 1, along with the line calculated from a formula producing a doubling of the rise for every half unit on the Richter scale.[10] The most severe earthquakes ever measured had intensities of 8.9 and 9.2. Even though the epicenters were offshore, they caused extreme destruction.[11]

Additionally, so far as I have been able to discover, earthquake scarps (breaks where vertical faults rise through the surface) seldom extend further than a few tens of miles.[12] They are not to be confused with inter-block faults like the San Andreas, whose motion is essentially horizontal. These extend hundreds of miles.

The vertical element must be played against the size of the highlands of which Ararat is a part. They extend nearly 500 miles east and 600 miles west of Ararat, ignoring the nearly continuous ranges extending across Asia. The north-south extent is well over 400 miles. Elevation throughout is over 6000 feet. For simplicity, let us ignore the lower rises on all sides and consider an ellipse 400 by 1000 miles, with an area of about 314,000 square miles. Ignoring further the numerous peaks more than 10,000 feet tall and the greater elevation generally, we posit that the area rose 6000 feet. Let us assume that a magnitude 9 earthquake can raise an area of 1000 square miles 100 feet. Over 18,000 earthquakes as large as any recently observed would have devastated the area. Assuming that the process took two centuries, an average of about 90 great earthquakes a year would have occurred in the area. Unless Noah and his family moved away quickly, they would have had everything they ever constructed shaken to pieces many times over.

A standard formula for the relation between the surface-wave magnitude and the Modified Mercalli Intensity at the epicenter is: $M=0.58I+1.5$ *if* $M = 8.5$, I = XII, the top of the scale.[13] The description for an intensity of XII reads in part: "Damage is total, and practically all works of construction are damaged greatly or destroyed." Already at XI, "Damage is severe to wood frame structures . . ." At X, "Most masonry and frame structures, and their foundations, are destroyed.[14]

Of course, the situation just after the rain ceased would have been worse. From the time the ark grounded until the dove found someplace to light was about four and a half months. The earthquake or earthquakes accompanying such a quick rise would have had magnitudes greater than any mentioned above. They would have been more than strong enough to tear the ark apart, especially since the ark rested on unconsolidated strata.

Pre-Flood Geology and Meteorology: "Canopy" and Caverns

What has just been said focuses on the immediate area of the grounding. But Morris has a further source of terrestrial turmoil at the start of the Flood, though he does not spell out its impact. There was a great reservoir of water, the "waters below the firmament."

> This was water in the liquid state, visible especially to the first man in the form of the antediluvian seas (Genesis 1:10) and rivers (Genesis 2:10-14).

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> These rivers were not produced by run-off from rainfall (Genesis 2:5), but emerged through controlled fountains or springs, evidently from deep-seated sources in or below the earth's crust. . . .
>
> Such subterranean reservoirs were apparently all interconnected with each other, as well as with the surface seas into which the rivers drained, so that the entire complex constituted one "great deep." The energy for repressurizing and recycling the waters must have come from the earth's own subterranean heat implanted there at the Creation. . . .
>
> When the time for the destruction of this world arrived, however, all that was required was to bring the two "deeps" together again, as they had been when first created. The waters above the firmament must be condensed and precipitated, and the waters below the crust must burst their bounds and escape again to the surface.[15]

This appears to require that the antediluvian continents collapsed into the reservoirs lying beneath them. Then the waters from these caverns plus the waters from the ancient seas and those condensed from the primordial "canopy" swamped the ancient land.

This "canopy," according to diluvianists, represents "the waters which were above the firmament" (Genesis 1:7). At one time, various authors held it to be a spherical layer of either ice or water above the atmosphere.[16] Such views run into two problems.

First, the only way we know that something can be "held up" in the required position is to have it in orbit. But there is no way that a solid spherical shell can be in orbit around the earth. All its parts would have to be in polar and equatorial orbits simultaneously, essentially moving in every direction at the same time. Second, such a structure would have to be within the Roche limit. The consequences of being within the Roche limit are visible in the rings of Saturn: bits and pieces. There were some who suggested that the "canopy" could be Saturn-like rings around the earth made up of fine bits of ice.[17] But this could not have had the required effect on the climate. So the current view has generally changed.

For Morris, the "canopy" was composed of clear water vapor, not the condensed droplets that form clouds. This could be supported by the lower atmosphere. Since pure water vapor is lighter than air, it could float, provided the gases could have been kept from mixing.[18]

According to the diluvianists, the resultant greenhouse effect eliminated all wind and rain storms.

Table 1. Earthquake Magnitudes & Changes in Elevation

Mag	Feet	Date	Location
3.4	0.04	29 June 1967	Greenville, MS
4.1	0.3	8 Dec. 1972	Thermopolis, WY
4.3	0.2	11 August 1976	Borrego Springs, CA
5.5	1.0	24 Jan. 1980	Livermore, CA
5.6	0.1	23 Jan. 1951	Calipatria, CA
5.7	0.02	7 June 1975	Northern CA
5.8	0.1	27 Jan. 1980	Danville, CA
6.1	0.2	25 May 1980	Owens Valley, CA
6.3	0.0	10 March 1933	Long Beach, CA
6.4	2.0	10 April 1947	Barstow, CA
6.5	0.5	30 Jan. 1934	Hawthorne, NV
6.6	0.3	15 Oct. 1979	Imperial Valley, CA
6.6	0.5	21/30 Dec. 1954	Eureka, CA
6.6	1.3	12 March 1934	Utah
6.6	1.5	6 July 1954	Fallon, NV
6.6	2.3	24 Feb. 1981	Corinth, Greece
6.6	3.3	9 Feb. 1971	San Fernando, CA
6.8	10.0	16 Dec. 1954	Fairview Peak, NV
6.9	3.5	28 Oct. 1983	Borah Peak, ID
7.1	4.0	18 May 1940	Imperial Valley, CA
7.1	8.0	Dec. 1954	Fairview Peak, NV
7.1	15.0	16 Dec. 1954	Dixie Valley, NV
7.1	21.0	17 August 1959	Hebgen Lake, MT
7.2	3.5	29 Nov. 1975	Halape, HI
7.3	13.0	10 Oct. 1980	El Asnam, Algeria
7.3	84.0	23 June 1946	Georgia Strait, BC
7.4	1.0	3 March 1985	W of Santiago, Chile
7.5	0.5	4 Feb. 1976	Guatemala
7.8	10.0	28 July 1976	Tang Shan, China
7.8	15.0	1811-1812	New Madrid, MO
7.8	15.0	2 Oct. 1915	Pleasant Valley, NV
7.9	4.6	1 Sept. 1923	Kanto, Japan
7.9	19.7	28 Oct. 1891	Mino-Owari, Japan
8.3	3.0	18 April 1906	San Francisco, CA
8.3	30.0	27 March 1964	Gulf of Alaska
8.5	3.0	20 Feb. 1835	Concepcion, Chile
8.5	20.0	26 March 1972	Owens Valley, CA
8.6	47.5	10 Sept. 1899	Cape Yakataga, AK
8.7	35.0	12 June 1867	Assam, India

The temperature would have been much warmer, and quite even from poles to equator. The total atmosphere (air plus "canopy") would have been deeper and consequently denser at the surface. The total mass of the current atmosphere is estimated as 5.1 to 5.7×10^{15} tons. Only a small part of this is moisture, approximately 0.5%. The total mass of water in earth's oceans is about 1.6×10^{18} tons. Therefore, if only a third of the water in the modern oceans were part of the earth's atmosphere, the atmospheric pressure at the surface would be greater than that of Venus.

A more realistic possibility, assuming the "canopy" did exist, might be to have as much as 1.5% of the current oceanic water in the "canopy." This would raise the atmospheric pressure at the surface of the earth to about what is considered the maximum safe pressure for scuba divers. Indeed, the only figures I have found suggested by Morris in this connection would be half or less of the 1.5%.[19] If the maximum 1.5% of oceanic water condensed out of the "canopy," the water level world-wide would rise no more than 140 feet. The water would rise only 50 to 70 feet if Morris's figures are used. Since the highest peaks were covered by 15 cubits of water at the height of the flood (that is, over 20 feet), the antediluvian mountains could have had an elevation no greater than 120 feet, provided that the "canopy" be the only source of water for the Flood. We cannot reasonably assume every mountain was so low, let alone 30 to 50 feet, especially since the continental area is claimed to be at least three times greater than today. Hence we must seek another mechanism to provide enough water for a total inundation.

The mechanism suggested comes from the "waters which were under the firmament" of Genesis 1:7. When the dry land appeared out of these waters, Morris argues, "an intricate network of channels and reservoirs opened up in the crust to receive the waters retreating off the rising continents."[20] These subterranean reservoirs connected to the antediluvian seas to form a unified system.[21] The reservoirs were pressurized so that they could provide flows at artesian springs great enough to feed the four rivers of Eden.[22]

Morris's description raises some problems. First, he claims that the ancient seas were much smaller than the present oceans,[23] and the ancient hills were low.[24] He does not speculate on how much smaller or lower. For the sake of argument, let us imagine that the highest of the ancient hills were only about a thousand feet high. For the ancient oceans, let us approximately reverse the current proportion of land

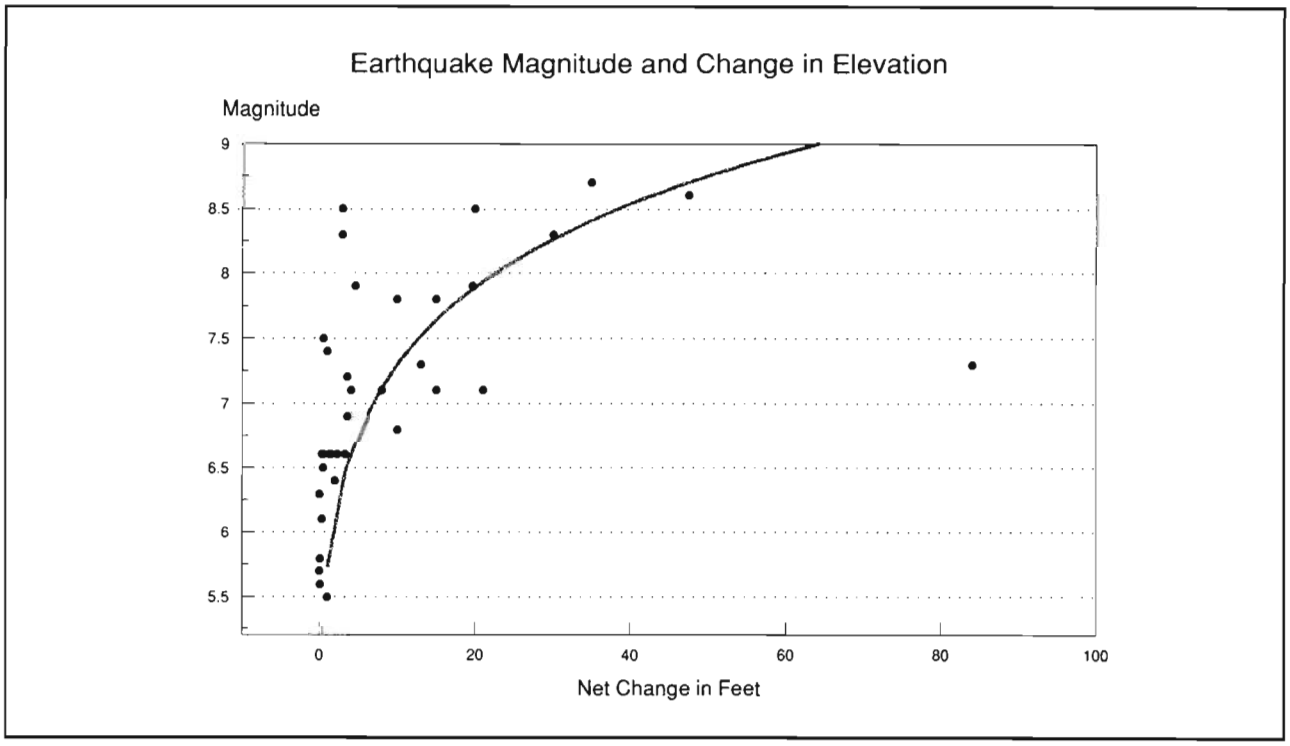

Figure 1. Earthquake magnitude & change in elevation, with projected curve superimposed.
(The curve in the graph is not a regression curve, but is calculated from the simplified formula.)

and water, but retain the current average depth. In this case, about 30% of the ancient surface was oceans. They would hold about 40% of the water in today's oceans. With no more than 1.5% of the water in today's oceans in the ancient "canopy," we must find space for nearly 60% of the currently available water in the subterranean reservoirs. This requires an average of over 1.3 cubic miles of water under every square mile of land. One may consider enlarging or deepening the oceans. But enlarging the oceans is not compatible with the need for vast amounts of vegetable material to be compacted into coal.[25] Deepening the oceans does not seem go along with a low profile for the land areas. Also, the ocean bottom is already probably lower than the bottom of the subterranean caverns.

However one tinkers with the seas, the proposed caverns will be large. Consequently, we must support the overlying land. Otherwise, it will fall through the water to the bottom of the caverns.[26] This may be one reason why Morris suggests that the caverns were pressurized. On the one hand, this would help to support the earth above. On the other, it would allow for massive artesian springs to feed the rivers of Eden.[27] But there are problems with the diagram of the water system given by Morris.

With no more than 1.5% of the water in today's oceans in the ancient "canopy," we must find space for nearly 60% of the currently available water in the subterranean reservoirs. This requires an average of over 1.3 cubic miles of water under every square mile of land.

In this system, the lower reaches of the sea are connected by insulated passages to the "Great Deep," the subterranean reservoirs, located at a lower level. The top of the reservoirs are connected to the surface of the earth at the top of a mountain by a large conduit. Heat flowing from deep in the interior of the earth warms the water in the "Great Deep," causing it to rise through artesian springs large enough to supply the rivers of Eden.[28] But warmed water will rise through any passage that trends upward, and sea level is lower than the tops of the hills. No wonder Morris elsewhere speaks a "system of reservoirs, valves, governors, and conduits."[29] But merely adding valves will not produce a one-way flow with constant heat. Intermittent heating plus valves can produce a pulsing flow. But there seems to be no way to get the heat of the earth's interior to change rapidly enough to provide adequate pumping, despite the assurance that the system "is quite feasible."[30]

A geyser-like mechanism could raise water the thousand feet suggested ... However, at the lowest hyperbaric pressure suggested by Morris, the temperature would still be about 230°. Rivers or lakes this hot could not benefit plants.

There are, however, two ways in which constant heat in part of a simple system can raise water the thousand feet suggested for the mountains. A geyser-like mechanism would work. Geysers are in principle simple; little more than a deep hole in the ground, requiring no valves or cycling rock temperatures. The cycle comes simply from the flow of water. The only problem is that a geyser depends on superheating water at the lower levels so that it flashes into steam as the water above it is discharged.[31] Under the higher atmospheric pressure suggested earlier, the exit temperature of the water would be about 290° F, much hotter than a hospital autoclave. At the lowest hyperbaric pressure suggested by Morris, the temperature would still be about 230°. Rivers or lakes this hot could not benefit plants.

The second way requires some explanation. The antediluvian climate, according to the theory, was affected by the "canopy." So I assume that the worldwide temperature was much like that of today's tropical islands, whose average annual temperature is about 77° F.[32] With the ancient air temperature essentially the same everywhere, the water temperature of all the seas would be like the air temperature, especially since there could be neither a mineral-concentration density gradient in a fresh-water ocean, nor a temperature-driven density gradient with the same temperatures worldwide. These gradients control deep-water currents in today's oceans.

So 77° is the input water temperature assumed. The temperature of the output water is restricted by its potential effect on the plants it will water. So let us consider an upper limit of 100° F. Water at 100° is slightly lighter than water at 77°.[33] So it is possible to balance a taller column of warmer water with a shorter column of cooler. To get the one column to the top of hills a thousand feet above sea level requires that the warmer column be over 46.25 vertical miles deep, and no place less than 100°. From sea level down to the bottom of the U, the shorter column, the temperature can nowhere be more than 77°. The first problem here is that these calculations are for a static balance. If water is to flow from the upper end, the cold water column must be deeper. Second, no matter the diameter of the columns, friction will strongly interfere with the flow. So the depth must be much greater, although this produces yet more friction. Third, temperature rises with depth: 131° F at the 12,391 foot depth of the deepest mine; 392° 6.82 miles down in the exploratory well on the Kola Peninsula, northern Russia.[34] So keeping the temperature below 77° for well over 46 miles down into the earth seems unattainable. Of course, with lower mountains, the column could be proportionally shorter. However, I find it difficult to imagine continents with no rise higher than a thousand feet above sea level. Indeed, it seems more likely that they would be higher.

The Smashing Deluge: Inverting Land and Water

But now, ignoring the problems just noted with the mechanisms suggested for the "waters which were under the firmament," we return to their part in the Flood. It appears that, on the theory proposed by the diluvianists, either a majority or the whole of the ancient earth's continental surface dropped into the subterranean cavities during the 40 days when the waters rose. On the most generous estimate, the "canopy" could not produce more than 150 feet of rain, and perhaps could only be responsible for 50 feet. The dry land, granting thousand-foot hills, may be assumed to have an average elevation of 500 feet. To inundate the entire area would then require an average drop of 350 to 450 feet. The most elevated parts would have to drop 850 to 950 feet, plus the 15 cubits of Genesis 7:20. Of course, if there were an average of 1.3 cubic miles of water under every square mile of continent, as noted above, the drop would average over 6800 feet. If we assume the empirically based formula for the relationship between earthquake magnitudes and terrestrial rise or fall, magnitudes of 11 or 12 are minimal.[35] These would be many times greater than any this century.

Additionally, if the ark were to float early in the flood period, the support would have to drop from under it. So at least one of these devastating earthquakes must have been centered near the location of the ark. Sitting over the epicenter of a great earthquake would have damaged the ark seriously, knocking it apart however it was built.

In the diluvianist theory, we have over a hundred million square miles of land dropping over a mile. Nothing sitting on shore could survive either the inciting earthquakes or the resulting waves.

Further, earth dropping into water has generated the greatest waves known. On July 9, 1958, a magnitude 7.9 earthquake caused landslides to cascade into Lituya Bay, AK. The resulting wave rose 1740 feet.[36] So it is hard to imagine what riding a block down into the subterranean caverns might have done to the ark.

On the other hand, if there were a collapse along the coast before the ark was afloat, a tsunami greater than any ever recorded could have been generated. In the 1883 eruption of Krakatoa, most of the island's five square miles collapsed into 820 feet of water. Waves some 115 feet high slammed into neighboring coasts, killing 36,000 people.[37] In the diluvianist theory, we have over a hundred million square miles of land dropping over a mile. Nothing sitting on shore could survive either the inciting earthquakes or the resulting waves.

A Summary of Impossibilities

The time for some decisions has arrived. First, the change of parameters in some arguments means that they fail to support diluvianism. Second, the difficulties raised by the connection between earthquakes and the rise of mountains have not, to my knowledge, been carefully evaluated. Similarly, apart from abandoning the notion that the "canopy" was a solid shell of ice, the restrictions on the amount of water that could be in the "canopy" have not

been thought out. It has been assumed that almost any amount of water could be placed in the upper atmosphere, ready to condense into hundreds or even thousands of feet of water to cover the entire earth.

Furthermore, the consequences of the amount of water that this theory requires to be stored under the antediluvial continents was not explored. Certainly the mechanism of the water cycle without precipitation was not adequately analyzed. Various matters, like the amount of vegetable material needed for the production of coal by a single event, the Flood, which were mentioned in notes, add to the total set of problems. Finally, the problems of a total collapse of the ancient continents have not been faced in the diluvianist literature.

Unless each of the total set of problems noted in this paper, to which may be added the problems of my earlier paper, is clearly answered, the diluvianist system is shown to be, for all practical purposes, impossible. If Morris, Whitcomb, Gish, Austin, and their fellows hope to rehabilitate diluvianism, they will have to rethink it from the beginning. They can be given no assurance that their effort, however sustained, will be successful.[38] ☆

NOTES

[1] "Some Relatively Non-Technical Problems With Flood Geology," David F. Siemens, Jr. *Perspectives on Science and Christian Faith*, pp. 169-174, Vol. 44, No. 3, September 1992.

[2] Henry M. Morris, *Science and the Bible* (Rev. ed.; Chicago: Moody Press, 1986), pp. 64f. See also *idem, The Genesis Record: A Scientific and Devotional Commentary on the Book of Beginnings* (Grand Rapids, MI: Baker Book House, 1976), p. 201. References to these books will be to *Science &* and *Genesis Record*, respectively, in subsequent notes.

[3] *Idem, The Biblical Basis for Modern Science* (Grand Rapids, MI: Baker Book House, 1984), p. 259. This book will be referenced as *Biblical Basis* in subsequent notes.

[4] *Ibid.*, p. 287.

[5] *Genesis Record*, pp. 195f

[6] John C. Whitcomb, *The Early Earth: An Introduction to Biblical Creationism* (Rev. ed.; Grand Rapids, MI: Baker Book House, 1986 [2nd printing, 1989]), p. 80.

[7] *Biblical Basis*, p. 287.

[8] See Bryce Walker, *Earthquake*, (Alexandria, VA: Time-Life Books, 1982), pp. 27, 32f, concerning what can happen when layers of clay are shaken and liquefy.

[9] Jerry L. Coffman *et al.*, eds., *Earthquake History of the United States* (rev. ed. with supplement; Boulder, CO: U.S. Department of Commerce, NOAA, and U.S. Department of the Interior, Geologic Survey, 1982). James M. Gere and Haresh C. Shah, *Terra Non Firma: Understanding and Preparing for Earthquakes* (New York: W. H. Freeman and Company, 1984). "Whittier Narrows Earthquake," *Science*, 239:1355 (18 March 1988).

Not included is the 750-foot change for the 1923 Kwanto earthquake in Japan. Gere and Shah do not mention it. John H. Hodgson, *Earthquakes and Earth Structure* (Englewood Cliffs, NJ: Prentice-Hall, Inc, 1964), p. 20, notes that the report is probably mistaken. Yoichiro Fujii and Katsumi Nakane, "Anomalous Crustal Strain Prior to the 1923 Kanto, Japan, Earthquake as Deduced from Analysis of Old Triangulation Data," *Pure and Applied Geophysics*, 117:1301, 1313 (1979), give the magnitude as 7.9 and vertical displacement as less than 140 cm.

Note that all magnitudes for earthquakes before about 1900 must be estimates. Seismographs were first developed about 1890. The Richter scale was developed in 1935. Note also that only vertical changes are noted. Many earthquakes involve horizontal movement, which, though important, cannot be quantified for the purposes here.

To minimize the effect on the diluvianist view, both subsidence and elevation are included. When both a rise and a fall are given, their absolute values were added, thus giving a maximum change for the associated magnitude, even though slumping cannot help to raise a mountain.

[10] The formula for the rise in feet, R, for each Richter magnitude, M, is

$$R = 2^{(2 \times (M-6))}$$

It gives a rise of 64 feet for a magnitude 9 earthquake. To give the benefit of any doubt to the diluvianists, I assume a 100-foot rise.

[11] See Gere and Shah, *op. cit.*, pp. 178f, for two measuring 8.9: Ecuador, 1906; Japan, 1933. The 1964 Alaska quake measured 9.2. Richard A. Kerr, "Big Squeeze Points to a Big Quake," *Science*, 252:29 (1991). Elsewhere, the last magnitude is given as 8.3-6 or 8.4. See, for example, Walker, op. cit., pp. 33f.

[12] The longest rise, about 100 miles, is associated with the 1964 Alaska earthquake. It is here taken as a single event with 8.3 magnitude, the lowest found in the literature (see note 11). Actually, six major, separate ruptures occurred along about 150 miles of fault, plus some 12,000 after shocks, including 17 with a magnitude equal to, or greater than, 6. For about 100 miles, the sea floor rose an average of six feet. In a parallel arc, the land dropped between 2.5 and 7.5 feet. An estimated 48,000 square miles subsided; 60,000 rose. See Walker, *op. cit.*, pp. 32-35. On the most generous assumptions, given the data, the average rise over 108,000 square miles was about 2 1/4 feet. The average is more likely about one foot. A figure of 30 feet was entered in the table and graph.

This data shows that the analysis of the connection between magnitude and rise is complex, something that is demonstrated also by the small shifts for other major earthquakes. My analysis is crude and simplistic. Yet it furnishes an empirical base for analysis which generally favors the diluvianist position.

[13] See W. H. K. Lee and D. R. Brillinger, "On Chinese Earthquake History—An Attempt to Model an Incomplete Data Set by Point Process Analysis," *Pure and Applied Geophysics*, 117:1232 (1979).

[14] "Earthquakes and Seismology," *Van Nostrand's Scientific Encyclopedia* (5th ed.; New York: Van Nostrand Reinhold Company, 1976), p. 850.

[15] *Genesis Record*, pp. 194f. See also *Biblical Basis*, pp. 258f; *Science &*, pp. 81-84.

If "below the earth's crust" is taken literally, the "waters below the firmament" would extend downward over twenty miles. As a consequence, the volume of falling rock in the computation in note 36 could be 200 times greater, adding 1.5 to the computed magnitude.

[16] *Genesis Record*, p. 59.

[17] *Ibid.*

[18] The density of a gas is proportional to its molecular weight. This is approximately 18 for water; and about 28 for nitrogen and 32 for molecular oxygen, which make up the bulk of the atmosphere. There is a pattern in the current atmosphere which may be used as a hint for a "layer" of gaseous water. Atomic oxygen (relative weight 16) is a major constituent of the rarefied atmosphere about 60 miles up, becoming the major constituent above 120 miles. Much higher is a layer of helium (4) and then a layer of hydrogen (molecular, 2; atomic, 1). See "Atmosphere," *Van Nostrand's Scientific Encyclopedia*, p. 215.

[19] See *Genesis Record*, pp. 59-61, 85, 142f, 194; *Science &*, pp. 82-84; *Biblical Basis*, pp. 286f.
[20] *Biblical Basis*, p. 280.
[21] *Biblical Basis*, p. 281.
[22] *Biblical Basis*, p. 281. *Genesis Record*, pp. 88f.
[23] *Biblical Basis*, pp. 286f.
[24] *Ibid.*, p. 259.
[25] World coal reserves, not including lignites, are estimated at 5.3×10^{12} tons. Lignites are estimated at 1.3×10^{12} tons. If we assume that only 50% of the coal and 25% of the lignite is carbon (although anthracite runs 92-98% fixed carbon, and bituminous as high as 86%), that all of the carbon came from cellulose and similar plant products, that the conversion of cellulose to coal lost no carbon, and that the land area of the prediluvial world was 70% of the total surface area, each ancient acre needed to be covered with over 60 tons of plant material. Obviously, the assumption of 100% efficiency at every stage in the process is ridiculous. So corrections for losses have to be inserted. A total factor of 3 or 4 is hardly sufficient. But that is the maximum that the data will allow. The biomass of today's tropical rainforests is usually about 160 tons per acre, with one area perhaps reaching 200. See Paul Westmacott Richards, "Ecosystems: Jungles and Rain Forests," *Encyclopedia Britannica* 1986), 17:1034. No temperate forests except those of mature redwoods top 140 tons per acre. See Geoffrey Kenyon Eliott, "Ecosystems: Boreal and Temperate Forests," *ibid.*, p. 1009.

The computations above do not provide for the grazing animals, who normally live on savannas or prairies. Grasslands have a biomass a small fraction of that of forests. Nor is there any place for agriculture. Including these would reduce the potential loss factor appreciably.

The figures for biomass cannot be equated to productivity in any simple way. In the dense growth of tropical rain forests, young trees cannot survive unless the fall of an old tree allows light to penetrate the dense canopy of leaves. So even if growing conditions were better because of more light, more water, greater warmth, the standing biomass can hardly exceed 200 tons per acre.

[26] Probably a quarter of the underearth area will have to be taken up by supporting columns of rock. The bottoms of the caverns will then be about 1.7 miles below sea level or, on the assumptions made, about 1.8 miles below the average land surface.
[27] *Genesis Record*, pp. 88f, 194f, 207. *Biblical Basis*, p. 281.
[28] *Biblical Basis*, pp. 281-283.
[29] *Genesis Record*, p. 195.
[30] *Genesis Record, p. 195.*
[31] "Geyser," *Encyclopedia Britannica* (1986), 5:231.
[32] From data in *Hammond Ambassador World Atlas* (Maplewood, NJ: Hammond Incorporated, 1984), pp. 480f, for Apia, Western Samoa; Bali, Indonesia; Havana, Cuba; Kingston, Jamaica; Las Palmas, Canary Is.; Noumea, New Caledonia; Papeete, Tahiti; Port-au-Prince, Haiti; San Juan, PR. Also for Honolulu, HI, from *Information Please Almanac* (Boston: Houghton Mifflin Company, 1990), p. 670. The range of average annual temperature was 69-82.
[33] Robert C. Weast, ed., *CRC Handbook of Chemistry and Physics* (62nd ed.; Boca Raton, FL: CRC Press Inc., 1981), p. F11, gives the density of pure water as 0.99707 gm/ml at 25° C = 77° F, and 0.99299 at 38° C = 100° F. The lengths equal 74.182 and 74.487 km. Were one able to use water at maximum density at 3.98° C and at 100° C, the longer arm would be only a little over 4 1/2 miles from surface to depth.
[34] Norris McWhirter, ed., *1986 Guinness Book of World Records* (24th ed.; New York: Sterling Publishing Co., Inc., 1985), pp. 198, 197. This measured rise is approximately half that of 1° F for 55 feet given by D. W. van Krevelen, "Fuels: Coal," *Encyclopedia Britannica* (1986), 19:603. Weast, *op. cit.*, p. F-163, is even higher at 86° F per mile. But he tags it "uncertain."
[35] On the diluvianists' theory, over a hundred million square miles of land had to drop nearly a mile and a half within a 40-day period. If the figures for area and elevation I have earlier suggested are taken, more than 140,000 square miles every hour disappear beneath the waters. Assuming an average thickness of 500 feet for the land above the reservoirs (too small to be realistic) and a specific gravity of 2.6, I calculate this to release a minimum of 3.6×10^{26} ergs per minute. This energy is equivalent to about a magnitude 10.1 earthquake every 60 seconds for the entire 40 days. If the release were not in these minute-sized packets, or if we take more realistic figures for the mass of land above the "Great Deep," the power of each earthquake could rise to even higher levels. Yet one can figure 10.1 as three Mercalli intensities beyond the total destruction of the top of the scale.

The formula, from Charles F. Richter, "Earthquakes," *Encyclopedia Britannica* (1986), 17:621, is:

$$\log E = 11.4 + 1.5M$$

where E is the energy in ergs and M is the Richter magnitude. Bolt, *op. cit.*, p. 249, with M_S as the Richter surface magnitude, gives:

$$\log E = 11.8 + 1.5M_S$$

[36] Walker, *op. cit.*, p. 31. Coffman, *op. cit.*, pp. 107f.
[37] Coffman, *op. cit.*, p. 107. Gere and Shah, *op. cit.*, p. 52.
[38] Thank you, referees, for useful suggestions.

Note added in proof: The June 28, 1992, Landers, CA, earthquake, magnitude 7.5, produced a 2 meter (about 6.5 foot) scarp pictured in *Time* (August 24, 1992), pp. 54f.

A Thought on Procedure

If the first item on an agenda is the formal adoption of the agenda,
no finite Thinking Machine can resolve the consequent halting problem.
By following such a procedure, we have therefore either
(a) proved that the human mind is not a finite Thinking Machine, or
(b) invalidated all subsequent items and decisions on the agenda as unconstitutional,
because if the mind is a finite Thinking Machine it cannot solve the halting problem
and hence the agenda could never have been adopted.

John C. Puddefoot
Benson House
Eton

Structure of Cytochrome c and c-like Genes: Significance for the Modification and Origin of Genes

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The author presents data on the structure of cytochrome c genes in various organisms including the gene for a tissue-specific (testes) cytochrome c. Nucleotide sequences in introns and in noncoding regions of the gene that precede and follow the coding region are discussed, along with regulatory sequences found in these regions. The possible role of design and chance is considered in discussing the origin of the testicular cytochrome c gene and in the origin of pseudogenes. The evidence is reviewed for homology of the various functional cytochrome c genes. Also discussed is the role of presuppositions in regard to hypotheses concerning the origin of informational molecules.

In this paper, I will describe recent studies on genes of cytochrome c, and will attempt to evaluate the significance of these studies on our understanding of evolutionary changes in cytochrome c proteins and in cytochrome c genes. In addition, I will discuss possible homologies of cytochrome c molecules and of the genes that code for and control synthesis of cytochrome c proteins.

Initially, I wish to note a 1987 paper proposing a more stringent usage of the words "homology" and "similarity." The following are quotations from that paper which was authored by eleven researchers in the field of molecular evolution:

> Homology should mean "possessing a common evolutionary origin" .... Evidence for homology should be explicitly laid out .... Sequence similarities (or other types of similarity) should simply be called "similarities" .... Homology among similar structures is a hypothesis that may be correct or mistaken, but a similarity itself is a fact, however it is interpreted.[1]

Since the meaning of these words is very important in making interpretations, I shall use the words "homology" and "similarity" in the sense agreed on by these eleven authors.

Amino acid sequences in cytochrome c protein molecules have been determined in about ninety different animal species. Similarities in these sequences have been used as a primary basis for determining relationships of these animals to one another. In many instances, (e.g., many high school biology textbooks) the similarities are cited as a major argument for ancestral relationships among various classes and phyla of organisms. Since the information for the sequence of amino acids in a protein molecule resides in the coding region* of the corresponding gene, in this paper I will review recent studies on nucleotide sequences in cytochrome c genes.

* See glossary on p. 245 for definitions of this and other selected terms.

This paper is a modification of one presented at the Annual Meeting of the American Scientific Affiliation at Messiah College, August 1990.

There are several distinctive differences that should be noted when we study sequences in genes instead of in proteins. First, it takes three nucleotides in the gene to code for one amino acid. Hence, for the linear sequence of 104 amino acids in human cytochrome c, the corresponding coding region of the gene would have a linear sequence of 312 nucleotides or 104 codons, with three nucleotides per codon. Secondly, a change in a coding region nucleotide (particularly in the third position of a codon) does not always cause a change in amino acids in the protein molecule. The reason for this is that there are 64 possible three-base arrangements of the four different nucleotides found in DNA coding regions, and only 20 different amino acids are found in proteins. Although some codons are used as start signals (initiation codons) or stop signals (termination codons), this means that there is more than one codon per amino acid. Thirdly, there are portions of the cytochrome c gene at the 5'-end and at the 3'-end of the coding region that are not involved in determining the amino acid sequence of the protein, but instead act by determining whether or not any protein is produced. Certain modifications in these control or regulatory regions may mean that no protein is produced, while other modifications may lead to a decrease in rate, or possibly to an increase in rate of protein formation. It is becoming increasingly evident that these control regions of a gene are just as important as the coding region of the gene.

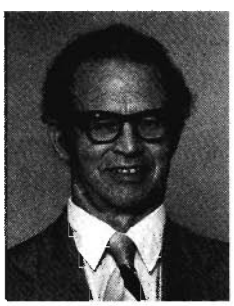
What is the special significance of studies of nucleotide sequences in cytochrome c genes? First of all, these studies extend sequence comparisons beyond coding regions to portions of genes that control expression of coding regions. Also, studies of other cytochrome c-like genes (pseudogenes) introduces a whole new and unknown element. Are these apparently nonfunctional cytochrome c-like genes remnants of the past evolutionary history of an organism? Or are they fragments of genes that are retained in the genome for possible incorporation into some new or different gene? Or are they just "junk" that will ultimately be broken down and eliminated from the organism? In this paper, the author will present and evaluate data related to the above problems, and suggest how certain presuppositions might have a role in our explanations and in formulating hypotheses.[2]

Cytochrome c Structure and Function

Cytochrome c functions in a respiratory chain in cells by virtue of having a heme prosthetic group. The central iron atom of the heme undergoes reversible oxidation and reduction during aerobic respiration. In mammals, the cytochrome c protein is made up of a linear chain of 104 amino acids, while in other eukaryotic organisms (organisms whose cells have a nucleus), the chain length ranges from 103 to 112 amino acids. Cytochrome c has a relatively fixed three-dimensional structure with fourteen different amino acids packed tightly around the heme. Several precisely defined channels permit the flow of electrons from the exterior to and from the heme iron. There are 21 amino acid positions in the cytochrome c molecule that are invariant (i.e., if they are replaced, enzymic function is lost). At approximately 20 other positions, the amino acid can be replaced only by one or two very similar amino acids.[3] Thus the picture we have of a cytochrome c molecule is one of a highly restricted three-dimensional structure with only limited possibilities for variation. This is consistent with conclusions made by the author in previous articles regarding the structure of hemoglobin[4,5] and of aminoacyl tRNA synthetases.[6]

Cytochrome c Gene Structure

The genetic information of cells (made up of many genes) is stored in the DNA of chromosomes of the



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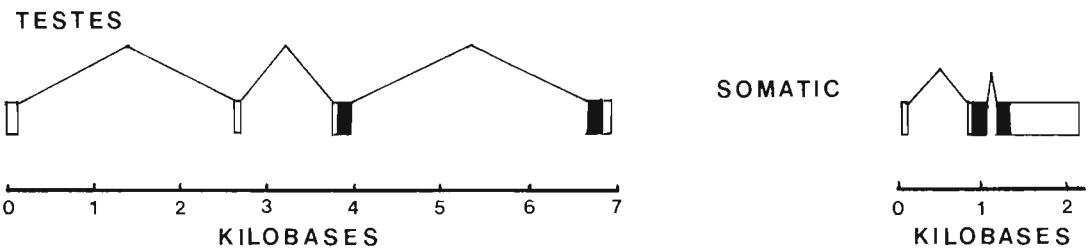
cell nucleus. To be expressed, that information is first copied into RNA (the process of transcription), and then is changed into sequences of amino acids in a protein molecule (the process of translation). Each of these processes is very complex, and I will not consider them in detail. It is never easy to determine where in the DNA of cells a gene begins or where it ends. The enzymes (restriction endonucleases) that are utilized to cleave huge DNA molecules into fragments amenable to study do not select sites for cleavage at the beginning or end of genes. Consequently, a number of different types of study, including the study of messenger RNA (mRNA) molecules, are necessary before one decides what makes up a particular gene.

Cytochrome c genes have now been sequenced in rat, mouse, chicken, human, fruit fly and yeast, largely due to studies by Wu and co-workers[7-10] and by Scarpulla and co-workers.[11-13] The techniques for isolation and sequencing of these genes are difficult and beyond the scope of this presentation, but great credit is due the researchers named above for their careful experimental work. The structure of the rat somatic cytochrome c gene (cyto c_s), which is found in all cells, and the gene of a cytochrome c isozyme found only in testes (cyto c_t) are shown schematically in Figure 1. It will be noted that there is an intervening nucleotide sequence (intron) in the middle of the coding region of the gene. Also, there are long stretches of noncoding nucleotide sequences at both the 5′- and 3′-ends of the coding region of the gene, with additional intron(s) in the 5′-noncoding region. All introns are precisely removed from the nucleotide sequence after transcription during the processing of mRNA. Consequently, mRNA that is utilized for protein synthesis has two separate coding regions joined together with no intron separating the two portions. Within noncoding regions of cytochrome c genes, there are short sequences of nucleotides that serve to control expression of the coding region (that is, to control translation of genetic information from nucleotide sequences to amino acid sequences). A great deal of research is presently underway in order to identify these various control or regulatory sequences.[14] Although I have shown a schematic representation of the cyto c_t gene as well as the cyto c_s gene in Figure 1, I will simply note at this point that there are marked differences in structure of these two genes. The significance of these differences will be considered in more detail later.

In Table 1, I have summarized some differences noted in cytochrome c genes of various species that have been studied. Note that introns are found in mammalian cytochrome c genes and in the genes of chickens, but introns are not found in the cytochrome c genes of fruit flies or yeast. It is interesting to note that the position of the coding region intron is the same in all cases (after the first position of codon 56), even though the length of the intron varies. Although the precise function of introns is not known, some control sequences have also been found in introns.

It may also be seen in Table 1 that some cytochrome c-like genes, termed "processed pseudo-

Figure 1



Schematic structure of rat cytochrome c genes. The filled boxes represent coding regions, the open boxes represent transcribed noncoding regions, while the thin lines represent introns. The 5′-end of the gene is to the left of the coding region and the 3′-end to the right. The somatic genes of human (HCS) and mouse (MC1) are structurally similar to the somatic rat gene (RC4), while the mouse cyto ct gene is structurally similar to the rat cyto ct gene. Adapted from Virbasius and Scarpulla.[12] (Figure used by permission.)

Table 1. Characteristics of Cytochrome c Genes[a]

	Pseudogenes found	*Coding region intron*		*5′-Noncoding region introns*[d]
		Position[b]	Length[c]	
Human	yes	56	101	one (1073)
Rat cyto c_s	yes	56	105	one (796)
Mouse cyto c_s	yes	56	104	one[e]
Rat cyto c_t	no	56	ca. 2600	two (ca. 2500,1050)
Mouse cyto c_t	no	56	very long[e]	n.d.
Chicken	no	56	167	none
Fruit fly	no	none		none
Yeast	no	none		none

[a] The somatic genes are: human, HCS; rat, RC4; mouse, MC1; chicken, CC9; fruit fly, DC4; and yeast, CYC1.
[b] All introns begin after the first nucleotide of this codon.
[c] In nucleotides.
[d] The numbers in parentheses indicate the length of these introns; n.d. = not determined.
[e] Reported to be of comparable length to the corresponding rat sequence.

genes," have been found in the different mammals that were studied, but not in chickens, fruit flies or yeast. The pseudogenes in rats or mice are clearly related to cyto c_s genes, but not to cyto c_t genes. Processed pseudogenes do not have introns and they have lost various control sequences in noncoding regions. In coding regions, the degree of difference of these pseudogenes from the functional cytochrome c gene varies markedly. In Figure 2, 13-nucleotide segments of nine different human pseudogenes are shown. This figure and the data in Table 2 illustrate the type of changes that occur. Some pseudogenes have extensive deletions or insertions of nucleotides and many nucleotide changes. Other pseudogenes have only a few nucleotide changes, and one pseudogene (RC9 of the rat) has the correct rat cytochrome c gene coding sequence. Nevertheless, these pseudogenes are all defective in some manner and are not used for production of functional cytochrome c molecules.

Probably the best explanation of the origin of these pseudogenes is that they were incorporated into DNA initially by reverse transcription of cytochrome c mRNA. This would account for their lack of introns. Once present in DNA, pseudogenes would be copied during cell division and hence would be passed from one generation of cells to the next. In order to be transmitted to subsequent generations of animals, pseudogenes would have to be generated either during formation of ova or sperm or of precursors of these cells. At present, 20 different cytochrome c-like pseudogenes have been studied (11 in humans, 6 in rats, and 3 in mice). None of these pseudogenes are identical.

The Tissue-Specific Isozyme of Cytochrome c (Cyto c_t)

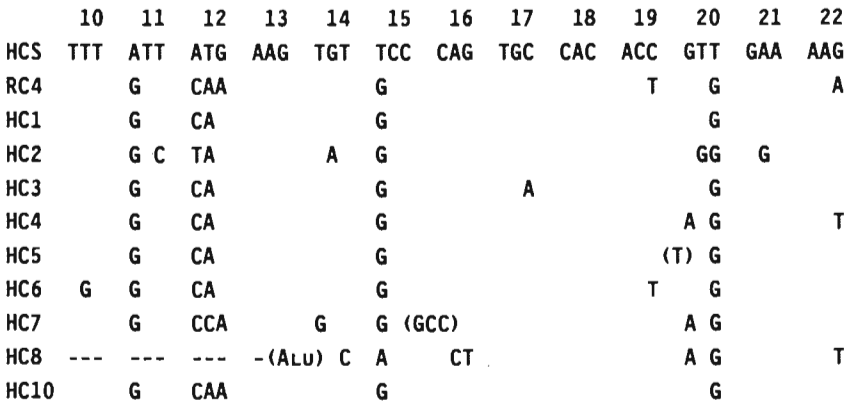
The report of a tissue-specific isozyme of cytochrome c in 1975 presented the possibility of some new and interesting aspects of cytochrome c studies. This finding opens again the question of the manner of origin of new enzymes or isozymes as one proceeds from lower to higher forms of life. The traditional answer to this question, at least for isozymes with appreciable sequence and structural similarity, has been to postulate a gene duplication, after which each of the two duplicate genes changes independently with time as a consequence of mutations, gene conversions, etc. I have examined the experimental evidence to see whether the above explanation may be applied to the formation of cyto c_t, the testicular isozyme of cytochrome c.[15] It should be noted, however, that nucleotide sequence studies at present have been made of cyto c_t only in rats and in mice.[16] Immunologic studies have shown the presence of cyto c_t in two other species (rabbit and bull), but the presence of cyto c_t has not been demonstrated in humans.[17]

Table 2. Alterations in Pseudogenes

Pseudogene	*Nucleotide*		*Frame-shift changes*	*Nucleotide changes*	*Amino acid changes*	*Invariant amino acid changes*
	Delet.	**Insert.**				
HC1	9(1)	0	0	23	14	4
HC3	3(1)	1(1)	1	27	15(+TC)	3
HC6	10(4)	1	4	27	17	5(+IC)
HS7	0	0	0	11	6	2
RC5	0	0	0	6	2	1
RC9	0	0	0	0	0	0
RC10	9(1)	0	0	20	5(+2TC)	2
MC2	11(3)	0	2	31	20(+TC)	6
MC3	16(1)	0	1	11	9(+TC)	5

Comparisons are made with the normal gene in each species (human, HCS; rat, RC4; mouse, MC1). They are for the coding region plus the initiation and termination codons (318 nucleotides). Abbreviations are: Delet. = deletions; Insert. = insertions; TC = termination codon; IC = initiation codon. The numbers indicate nucleotide deletions, insertions or changes, or amino acid changes; numbers in parenthesis indicate the number of nucleotide segments (i.e., 9(1) indicates 9 nucleotides in one segment). The 9 pseudogenes listed above illustrate the range of types of changes found in the 20 pseudogenes. A frame-shift is caused by any deletion or insertion of nucleotides (1,2,4,5,7, etc.) that would cause a misreading of codons after that point in the nucleotide sequence.

Figure 2



Nucleic sequence comparison of a small segment of coding regions from the human gene (HCS), the rat gene (RC4) and nine human HC pseudogenes. Only nucleotide differences from the HCS gene are shown. Abbreviations: *A* = adenine; *G* = guanine; *C* = cytosine; and *T* = thymine. Codon numbers are presented above the nucleotide sequence. Deletions of nucleotides relative to HCS are indicated by dashes, and insertions by enclosure within parentheses (open parenthesis located below the nucleotide preceding the insertion). An *Alu* nucleotide segment is one that is often found inserted into pseudogenes. Its significance is not known. Adapted from Evans and Scarpulla.[13] (Figure used by permission.)

An examination of amino acid sequence data for cyto c_t and a comparison of it with cyto c_s data presents some very striking differences. Rat cyto c_t differs from rat cyto c_s in 15 positions of the amino acid sequence of the protein, while mouse cyto c_t differs from mouse cyto c_s in 14 positions. Rat and mouse cyto c_t differ in 4 positions, whereas rat and mouse cyto c_s proteins are identical. The differences between cyto c_t and cyto c_s proteins do not involve invariant amino acids; in fact, most of these differences involve amino acids on the exterior of the three-dimensional molecule. However, many of the amino acid differences are of a radical nature. By radical, I mean that the nature of the R-group of the amino acid has been markedly changed (that is, a hydrophobic group for a hydrophylic group; a charged group for a neutral group, etc.) Also, amino acid differences in cyto c_t of either rat or mouse are not commonly seen when one examines other cytochrome c sequences. Thus, the experimental evidence involving amino acid sequence data indicates that cyto c_t is quite divergent from somatic cytochrome c of all other organisms, and can not be readily related to somatic cytochromes c in any postulated phylogenetic tree.[18]

A nucleotide difference matrix for the coding region of cytochrome c genes is shown in Figure 3. In this matrix I have provided data not only for the gene of the primary cytochrome c of cells, but also for the gene of the tissue-specific isozyme of rats and mice (cyto c_t) and for the minor cytochrome c genes of fruit flies (DC3) and yeast (CYC7). Thus these studies on coding region sequences are in agreement with the studies involving amino acid sequences; namely, that there is a large divergence of the cyto c_t isozymes from the somatic cytochromes c. In addition, from the time of divergence of rats and mice, genes for cyto c_t isozymes in these two rodents have diverged much more than genes for the corresponding cyto c_s isozymes.[19]

If we examine noncoding regions of the cyto c_t gene of rats, no similarity is found with corresponding positions of the cyto c_s gene of rats. This means that if genes of these two cytochrome c isozymes did arise by a gene duplication, then all controlling sequences in these noncoding regions have been replaced during the evolutionary history of the gene. This indicates that genes of the cyto c_t isozymes are even more different from the corresponding cyto c_s genes than would have been suggested by examining only the coding region nucleotide sequences. If indeed the genes for these two cytochrome c isozymes did arise by gene duplication, is there some built-in control mechanism (possibly subject to chance events) that could be responsible for subsequent changes? Such a built-in control mechanism would, when triggered, lead to the replacement of the noncoding region controls that are appropriate for a somatic enzyme with new controls that are necessary for a gene that functions only in a single tissue (that is, in sperm cells of testes). In other words, is the origin and function of the cyto c_t isozyme a consequence of the initial design built into the genes (although possibly triggered by chance events), or is the origin of the new isozyme entirely subject to a sequence of chance events (that is, one chance event after another leading to the replacement of all the necessary nucleotides in the coding region and the replacement

Figure 3

	HUMAN (HCS)	RAT (RC4)	MOUSE (MC1)	CHICKEN (CC9)	FRUIT FLY (DC4)	YEAST (CYC1)	RAT CYTO c_t	MOUSE CYTO c_t	FRUIT FLY (DC3)	YEAST (CYC7)
HUMAN (HCS)	0	34	31	58	87	110	83	82	106	112
RAT (RC4)	34	0	9	53	83	117	76	72	110	120
MOUSE (MC1)	31	9	0	58	77	119	76	72	104	117
CHICKEN (CC9)	58	53	53	0	92	119	76	76	115	119
FRUIT FLY (DC4)	87	83	77	92	0	123	103	103	94	127
YEAST (CYC1)	110	117	119	119	123	0	123	122	134	74
RAT CYTO c_t	83	76	76	76	103	123	0	22	117	127
MOUSE CYTO c_t	82	72	72	76	103	122	22	0	116	123
FRUIT FLY (DC3)	106	110	104	115	94	134	117	116	0	133
YEAST (CYC7)	112	120	117	119	127	74	127	123	133	0

Nucleotide difference matrix for cytochrome c genes. Coding sequences only are compared. (104 codons and 312 nucleotides, except for fruit fly (*Drosophila melanogaster*) and yeast (*Saccharomyces cerevisiae*) genes, where 103 codons are compared.) The DC3 and CYC7 genes are minor genes of fruit flies and yeast that are expressed only weakly.

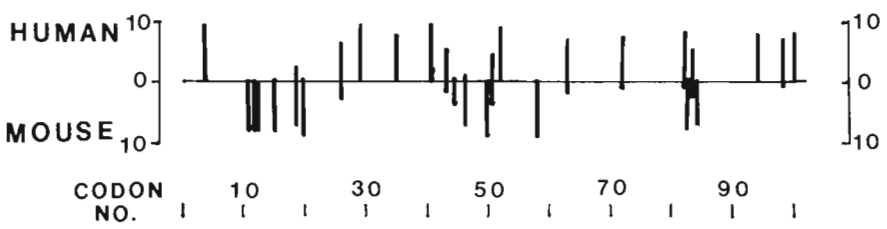
of all the necessary control regions in the noncoding regions of the genes)? At present, we do not have answers to these questions, but it is clear that one's initial presuppositions regarding origins may have a role in the development of hypotheses to be utilized in guiding subsequent laboratory investigation in this area.[20]

Significance of Processed Pseudogenes

As mentioned previously, twenty different cytochrome c-like pseudogenes have been studied in mice, rats and humans. Evans and Scarpulla[21] noted that nine of the eleven pseudogenes in humans appeared to be more like the functional rodent somatic cytochrome c genes than they were like the functional human cytochrome c gene (HCS gene). They based their conclusion on similarities that were readily evident (see codons 11, 12, 15 and 20 of Figure 2). These authors indicated that these nine human pseudogenes (designated HC pseudogenes) had much greater similarity to a consensus of nonprimate mammalian cyto c_s genes, and consequently would have remained as a nonfunctional part of the mammalian genome for 25 million or more years. In effect, this means that there are molecular remnants remaining in an organism that may reflect some of the past molecular history of the genome of that organism. I have examined the data of Evans and Scarpulla[22] carefully to see if their interpretation is clearly supported by the data. To do this, I have compared coding region sequence data for these nine pseudogenes with sequence data for the human HCS gene and the mouse MC1 gene, both of which are functional. Data in Figure 4 are for all positions where nucleotides of the MC1 gene differ from those in the HCS gene. As seen in Figure 4, there are indeed some portions of these nine human pseudogenes (for example, codons 10-22 and 44-51) that more nearly resemble the mouse gene. However, more than half the length of each of the pseudogenes more closely resembles the human gene. This suggests that portions (especially codons 10-22, and possibly codons 44-51) might possibly have been introduced into the pseudogene as a unit as a consequence of a gene conversion. I have no suggestion about where these gene segments that appear to have been introduced may have come from initially. It is important to note also that none of the twenty pseudogenes have any unusual similarity with any of the other pseudogenes of the same species or of other species.

I believe, therefore, that the data do not necessarily support the conclusion of Evans and Scarpulla that the nine human pseudogenes were all derived from a consensus of nonprimate mammalian cyto c_s genes. However, the statement by Evans and Scarpulla that the nine HC pseudogenes likely originated from an ancestral form of the HCS gene still appears to be valid. How ancient that ancestral form may be, cannot easily be established when sequence changes in pseudogenes involve insertions, deletions and possibly gene conversion events. At the same time, I must add that no one at present knows the role,

Figure 4



HC Pseudogene comparisons. The 31 nucleotide positions where the human HCS gene differs from the mouse MC1 gene are compared with these same positions in 9 human HC pseudogenes. The vertical lines above the horizontal line indicate positions of similarity with the HCS gene, while vertical lines below indicate positions of similarity with the MC1 gene.

if any, of these pseudogenes in the mammalian genome. When one examines the data in Table 2 closely, it is evident that dramatic changes would be required for most of these pseudogenes to ever be used for production of functional cytochrome c molecules. On the other hand, is there a possibility that segments of these pseudogenes could be used as a reservoir of genetic information for the production or modification of other proteins? At present that possibility seems unlikely, but it is clearly not impossible. The comment of Neel[23] in his Presidential address to the Sixth International Congress of Human Genetics is pertinent in this regard:

> In viewing the DNA which is in excess of the needs we can visualize for it as "junk," a hodgepodge of genes rendered useless by evolutionary advance, we have been engaging in an exercise of considerable arrogance.

We should keep our humility and wonder, and with Neel, consider ourselves "privileged to witness and contribute to an unfolding story whose final implications we can only dimly foresee."[24]

One of the cornerstones of molecular evolutionary theory has been that proteins (and hence genes) have changed progressively through time as one ascends the phylogenetic tree. This author in 1968[25] raised the following question in regard to protein sequences: *if these sequence changes have occurred in the past, they presumably are occurring now. Why is there not marked heterogeneity in protein structure in each species that would show protein sequences in intermediate stages of change?* Granted that there is some heterogeneity, but it is clearly not extensive. Also, it has generally been accepted that all intermediate stages of proteins or genes would have to be at least minimally functional. Does the finding of pseudogenes change the answer to the questions posed above? If the pseudogenes noted in humans, rats and mice retained functional coding sequences and controls, then we might consider them as possible candidates for functional genes in the distant future. Since most of the pseudogenes are altered so markedly, the possibility of future function (at least as the same gene) still seems remote. This new knowledge of the structure of pseudogenes then provides additional support for the view that whatever major changes may have occurred throughout evolutionary history, these changes have been a consequence of design, even though the initiation of these design changes may have been triggered by chance events.

Evaluation of Similarity and Homology in Cytochrome c Genes

Now that we have examined some of the experimental data regarding cytochrome c genes and pseudogenes, let us return to some of the questions posed in the introduction, particularly in regard to similarity and homology. First, let us compare the somatic proteins (cyto c_s) and genes for these proteins in rats and mice. Based on evidence from paleontology, rats and mice are believed to have diverged from a common rodent ancestor about 30 million years ago. The amino acid sequence similarity for the two cyto c_s proteins of rats and mice is 100%, the nucleotide sequence similarity for the coding region of the two cyto c_s genes is 97.5%; and nucleotide sequence similarities in the 5'-noncoding region, the 3'-noncoding region and the coding region intron are 86%, 91% and 84%, respectively. I believe, therefore, that the evidence is quite strong that rat cyto c_s and mouse cyto c_s genes and proteins are homologous, thus supporting the view that there was a common rodent ancestral gene and protein. If we make similar comparisons for rat and mouse cyto c_t proteins and genes, the similarities are not quite so striking. The amino acid similarities are 96%; the nucleotide coding region similarity is 93%; while for the 5'-noncoding region and the 3'-noncoding region the corresponding values are 92% and 65%, respectively. However, it should be noted that only a short portion (105 nucleotides) of the 3'-noncoding region was available for comparison. Whether this low similarity value is indicative of the entire 3'-noncoding region is not known. Also no data was available to compare coding region introns of the two rodent cyto c_t genes. Although one may presume that the two cyto c_t genes are both derived from an ancestral rodent gene, additional data are needed to clearly establish that relationship. It is also clear from the above comparisons that from the time of divergence of rats and mice, the cyto c_t genes have diverged more rapidly than cyto c_s genes.

However, when we make the corresponding comparisons of the rodent cyto c_t proteins and gene with rodent cyto c_s proteins and genes, the following values for similarity are obtained: amino acid sequence similarity, 86%; nucleotide sequence similarity of the coding region, 76%; nucleotide sequence similarity of the 5'-noncoding region, the 3'-noncoding region, and the coding region intron, no similarity. In this comparison, although the postulation of a gene duplication as the mode of origin of the cyto c_t gene may appear plausible, the present evidence is insufficient to support that hypothesis. Consequently, we cannot say at the present time that genes for the two isozymes of cytochrome c are homologous. At present, the question regarding the origin of the cyto c_t gene must remain unanswered.[26] It is evident that more studies are needed to see whether the cyto c_t gene is present in a wide variety of species, including additional classes other than mammals.

Also, if the gene is found in testes of other species, is it expressed as a functional protein in sperm? More complete sequences in noncoding regions and in introns might provide clues regarding the extent of change in control regions among various species, genera, orders and classes of organisms. This again might provide insight into the question of whether the possibility of change in these control or regulatory portions of genes is built into the initial design of an organism's genome (although possibly triggered by chance events), or whether changes are entirely a consequence of sequential chance events (mutations, gene conversions, etc.).

There are some interesting questions regarding the origin of the minor isozymes of cytochrome c found in fruit fly and in yeast (see the nucleotide matrix, Figure 3). In each case, the gene for the minor enzyme (DC3 or CYC7) is very divergent from the gene for the major enzyme (DC4 and CYC1). Did the minor enzyme genes arise by gene duplication? If so, what path did the divergence follow to arrive at the present sequence? I will simply note the problem here, since space will not permit me to deal with questions regarding these two minor cytochrome c isozymes.

Theological Relationships

As this author has previously noted,[27] differences in presuppositions may markedly alter questions one may ask regarding origin events. If one accepts the presupposition "that everything may be explained by natural processes," then one must explain how each gene was formed from an ancestral gene. The ancestral gene in turn would have to be relatively simple, since it would have to be formed by chance events from simple precursors. There has been no reasonable scientific proposal for the formation of significant new genetic information (e.g., a gene for a 100 amino acid protein molecule) without the postulation of an intelligent cause. As noted previously,[28] postulating that a protein (e.g., cytochrome c) would form by chance is not scientific, when the probability of chance formation is 2×10^{-65}. In contrast, if one is open to the presupposition of an intelligent cause, one is free to consider the possibility that ancestral genes may initially have been reasonably complex, even containing appropriate regulatory sequences.

As one examines organisms on any phylogenetic tree, it is clearly evident that many simple organisms (e.g., bacteria) contain genetic information that is not present in mammals. More importantly, mammals contain a great deal of genetic information that is not present in simple one-celled organisms. It is not too difficult to postulate how genetic information may be lost, but it is far more difficult to explain how new genetic information may arise. Gene duplication is most often postulated, but even with gene duplication, the information, although duplicated, is not new. Transfer of gene segments (gene crossovers) may have a role in the formation of some gene families, but again this does not provide new genetic information. Viral genetic information may clearly be incorporated into genes at all phyletic levels, but again this is not new genetic information. I would not attempt to explain how new genetic information may have arisen at various levels of organisms, but would simply postulate that genetic information is present as a consequence of an intelligent cause.

Is it possible that at some level (phyla, classes, orders, genera?), the genetic information is present but not expressed in an ancestral organism, and that this genetic information might subsequently be expressed and processes be initiated leading to species diversity? Could the trigger to initiate the expression of these repressed genes possibly be a chance mutation of a regulatory sequence in a gene that might occur once in a million or more years? The genetic information then expressed might then account for significant changes in organisms. This type of postulation, although reasonable, may prove to be incorrect, but it does illustrate the different type of reasoning possible if one considers not only chance causal events, but also the possibility of an intelligent cause.

In the present paper, the author has used genes and pseudogenes of cytochrome c as models for consideration of some of the most fundamental questions of biology. Although the relationship between these studies and origin questions may not always be clear, it is hoped that this paper will provide the reader with some insight into current areas of investigation that have theological implications. In the author's opinion, scientific research involving the question of origins, including the origin of informational molecules, has been unnecessarily restricted because of the nearly universal acceptance of the view that only chance events must be considered as possible scientific explanations of origin questions.

Whatever the explanation for the origin of genetic information may be, and whatever the roles of design and chance, it is the author's conviction that God is sovereign over all. ☆

NOTES

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[15] Mills, G.C. (1991). "Cytochrome c: Gene Structure, Homology and Ancestral Relationships." *J. Theor. Biol.* 152:177-190. Additional references related to cytochrome c can be found in this paper.

[16] See note 12 above.

[17] See note 13 above.

[18] See note 15 above.

[19] See note 15 above.

[20] See note 2 above.

[21] See note 13 above.

[22] See note 13 above.

[23] Neel, J.V. (1982). "The Wonder of Our Presence Here: A Commentary on the Evolution and Maintenance of Human Diversity." *Perspectives Biol. Med.* 25:518-558; p. 547.

[24] *Ibid., p. 551.*

[25] Mills, G.C. (1968). "The Evolutionary Significance of the Species Variation in Cytochrome c Structure." *J. Amer. Sci. Affil.* 20:52-54.

[26] See note 15 above.

[27] See note 2 above.

[28] See note 2 above.

GLOSSARY

Coding region of a gene: The portion of a gene that provides the sequence information for the formation of a specific protein.

Codon: The three-nucleotide segment of a gene that codes for a particular amino acid.

Control or regulatory sequence: A sequence of nucleotides in a gene, but outside of the coding region, that controls the expression of the gene; usually 5-15 nucleotides long.

Expressed gene: A gene whose coding region information is expressed in the formation of a specific protein. It is contrasted with a repressed gene.

Eukaryotes: Organisms that have nucleated cells, including yeasts and all higher organisms.

Genome: The total of DNA informational molecules in the cell nucleus of an organism.

Heme prosthetic group: The iron protoporphyrin that provides the catalytic group that permits the cytochrome c protein to function as an electron carrier.

Intron: An intervening DNA segment within the gene that is precisely excised following transcription prior to use of the mRNA for protein synthesis.

Isozymes: Two different but similar proteins that perform the same enzymatic function. In most cases, they have appreciable amino acid sequence similarity.

Non-Coding regions of genes: Those portions of a gene at either end of a coding region (5′ end or 3′ end) that are transcribed but do not provide sequence information for a protein. They *do* contain control or regulatory sequences.

Nucleotide: A purine (adenine or guanine) or pyrimidine (cytosine, uracil or thymine) linked to a sugar (ribose or deoxyribose) which is linked to a phosphate.

Pseudogenes: DNA segments in the cell nucleus with nucleotide sequences similar to coding sequences of known functional genes. They are not expressed as proteins. Processed pseudogenes do not have introns or most non-coding control sequences.

Respiratory chain: The group of enzymes which act as a catalyst to the transfer of electrons from a donor compound to oxygen with trapping of energy in the form of ATP; found in all cells with aerobic metabolism.

tRNA and mRNA: Transfer RNA (ribonucleic acid) and messenger RNA; both are involved in the translation of genetic information from a sequence of nucleotides to a sequence of amino acids (protein formation).

Somatic genes: Genes that are present and expressed in all nucleated cells of body tissues. These contrast with tissue-specific genes that are expressed only in certain tissues; for example, testes.

Communications

God Versus Scientists' Use of Animals?

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In today's climate it should not surprise scientists who use animals as experimental subjects or in teaching that those of the animal rights movement may react to this.[1] Such an encounter occurred while the author was involved with teaching human ophthalmologic residents the technique of phacoemulsification.[2] A representative from a large animal rights group recently came to our university to "review" our teaching procedures. While there she planned to interrupt the class in progress, posing questions and making statements which implied that even if one accepted the divine inspiration, trustworthiness and authority of the Bible in matters of faith and conduct, the use of animals in research and teaching was indefensible. I intercepted her before she reached the classroom, and we had a rather lengthy discussion in my office instead.

I had not previously encountered and so did not expect this type of query and pontification from such an individual. Although the proclamations issued by this individual may at first glance seem sound, closer examination reveals that they are patently erroneous or involve scripture quoted out of context. I have formulated some answers to these questions, which I hope will be useful to others who address similar situations.

Man and Other Species Are Not Equal

In the scriptural sense, all species simply are not equal, as some animal rights activists maintain.[3] The biblical writings do not agree with the view that "A rat is a pig is a boy is a dog," a statement attributed to Ingrid Newkirk of the People for the Ethical Treatment of Animals (P.E.T.A.).[4,5] In fact, scripture says:

> So God created man in his own image — male and female he created them. And God blessed them, and God said to them, Be fruitful and multiply, and fill the earth and subdue it; and have dominion over ... every living thing that moves upon the earth. (Genesis 1:27-28) (RSV)

The Lord also commanded that animals be sacrificed.

> ... and you shall kill the bull before the Lord at the door of the tent of the meeting ... (Exodus 29:11)

> Then came the day of unleavened bread, on which the passover lamb had to be sacrificed. (Luke 22:7)

Also, it should be noted that God did not promote a vegetarian diet and permitted the eating of meat.

> And the Lord said to Moses and Aaron, "Say to the people of Israel, these are the living things which you may eat among all the beasts that are on the earth." (Leviticus 11:1-2)

> ... and bring the fatted calf and kill it, and let us eat ... (Luke 15:23)

These statements do not support the theory of equality of all species. If one were to carry this argument to its logical end, one would have to conclude that it is as wrong to harm members of the lowest classical animal phylum, Protozoa, as it is to injure a human being. Therefore, for example, it would be immoral to treat a human baby for malaria for fear of harming the malaria organisms (which are animal species of the phylum Protozoa).

"Thou Shalt Not Kill" is Not Applicable to Animals.

The King James version's "Thou shalt not kill" literally translated means "thou shalt not *murder*" (Exodus 20:13; Matthew 5:21). The word used in the Old Testament is the Hebrew *ratsach;* that word in the New Testament is the Greek *phoneuo.* Both refer to an individual personally committing an act of violence against another person. These terms are never used in the Bible to refer to the killing of animals. *Ratsach* and *phoneuo* are not used in scripture when referring to either slaughtering an animal for food or sacrifice, or for causing death in war. For animals, the Hebrew *zabach, tabach,* or *shachat* (Exodus 29:11; Deuteronomy 12:15; I Samuel 25:11) and the Greek *thuo* (Luke 15:23) are used. Words used to describe depriving an enemy of life in war are the Hebrew *muth* (2 Samuel 21:15-17) and the Greek *apokteino* (Acts 27:42). Thus, it is simply not true that the biblical commandment that "thou shalt not kill" does not limit itself to our species, a statement sometimes made by those in the animal rights movement.[6]

Peaceful Co-existence for All Species Is Not for This Age.

The following passage from the book of Isaiah is offered by some as evidence of God's will to have peaceful co-existence among all species.

> The wolf shall dwell with the lamb, and the leopard shall lie down with the kid, and the calf and the lion and the fatling together ... (Isaiah 11:6)

Examination reveals, however, that the discourse is speaking of another world order at some time in the future, not now. This same chapter also asserts that

> ... the lion shall eat straw like the ox.

In terms of God's law now, anyone who believes that there is currently peaceful interaction in the wild among all animal species with no killing, or that this type of interaction could be readily promoted, simply demonstrates that they have no understanding of how animals exist in those surroundings. Carnivores kill other animals for the sake of survival. It is pure nonsense to believe that peaceful co-existence among all species can exist while some animals must die so that others may survive.

In Fact, There is a Moral Imperative to *Use* Animals

The immorality that may exist in this situation is in *not* using animals for the purposes of alleviating or preventing human pain, suffering and death. To deny that animal research has been successful is simply to ignore the truth or else to accept the facts and deliberately lie about them. The reality is that virtually every advance in medical science in the 20th century has been achieved either directly or indirectly through the use of animals in laboratory experiments.[7] Of course, there is much more to be done — AIDS, cancer, Alzheimer's disease, aging, and countless other diseases or disorders. The irony of it all is that animal research greatly benefits pets and other animals by combating rabies, distemper, parvo virus, infectious hepatitis, anthrax, tetanus, and feline leukemia — just to name a few.

I am also compelled to comment upon what seems to be an inconsistency in the view of those who consider themselves a part of the animal rights group. On the one hand there are statements by these activists about how immoral it is to use animals in research and teaching. On the other hand, I know of no activists who refuse treatments that are based on the fruits of that research and teaching, whether it be vaccinations for such diseases as smallpox, poliomyelitis, or measles; life-saving techniques such as blood transfusions, burn therapy, open-heart or brain surgery; or medications like antibiotics, steroids, insulin, or anti-hypertensive drugs.

Most of us have animals that are members of our families. I know that I do. I and the others of our household feel the warmness, gentleness and the protectiveness toward these canine and feline companions. They are a part of us. But there is also a moral obligation to alleviate human injury, disease and grief. I have four sons who are subject to being called to serve by going to war. I hate the thought of one of them lying wounded somewhere on a battlefield and perhaps dying because some health professional (maybe a surgeon) did not know how to properly handle the trauma — something that this health professional could have learned on subjects (like pound animals) that were going to be put to death anyway. It should be emphasized that this training is accomplished without pain to the animals employed. The subjects are fully anesthetized before any procedure is begun, and afterwards put to sleep without ever regaining consciousness.

Under no circumstances should those of us who utilize animals in our research or teaching permit any unnecessary pain or suffering to our subjects.[8]

But there should also never be a need to apologize for conducting this labor of love and compassion. Indeed, we need to welcome those who are genuinely interested in our profession and the way it is conducted. But to shrink from carrying out this work, which is vital, is to avoid responsibility. It is our duty to boldly press on. ☆

NOTES

[1] The opinions or assertions contained herein are the private views of the author and should not be construed as official or necessarily reflecting the views of the Uniformed Services University of the Health Sciences or the Department of Defense.

[2] Phacoemulsification is a sophisticated form of extracapsular cataract extraction. It permits the removal of a cataract through a 3.0 mm incision. Thus, it eliminates many of the complications of healing related to large-incision cataract surgery. It also significantly shortens the recuperative period. This procedure entails fragmenting the cataract, which allows it to be aspirated.

[3] Singer, Peter, *Animal Liberation: A New Ethics for Our Treatment of Animals*, Avon, New York, 1975.

[4] McCabe, Katie, "Who Will Live and Who Will Die," *The Washingtonian* 21:112-156, 1986.

[5] Horton, Larry, "The Enduring Animal Issue," *J National Cancer Inst* 81:736-743, 1989.

[6] The various meanings of these Hebrew and Greek words may be obtained by employing *Young's Analytical Concordance to The Bible* (22nd ed., Robert Young. Wm. B. Eerdmans, Grand Rapids, Mich.). I used as backup for the Hebrew *The Holy Scriptures According to the Masoretic Text* (The Jewish Publication Society of America, Philadelphia, 1955); and for the Greek *The Interlinear Greek-English New Testament* by Nestle/Marshall. (Eberhard Nestle's 21st edition of *Novum Testamentum Graece* with the translation by Alfred Marshall, 2nd edition. Zondervan, Grand Rapids, Mich., 1959.)

[7] American Medical Association White Paper, "Use of Animals in Biomedical Research: The Challenge and Response," 1989.

[8] Subjects should always be maintained and cared for in accordance with the provisions of the *Public Health Service Policy On Humane Care And Use Of Laboratory Animals*, 1986.

How Science Works: The Views of Gingerich and Johnson

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Being an admirer of both Owen Gingerich and Phillip Johnson, I was frustrated to read Gingerich's closing paragraph in his review of Johnson's *Darwin on Trial* (*PSCF*, 44:2, p. 142):

> So, what does Johnson want us to do about all this? Abandon teaching evolution in schools? Teach it as a scientific myth? Give creationists equal time? He call the writers of the ASA *Teaching Science in a Climate of Controversy* "naive," but he seems to offer no obvious prescription. If he understood better how science functions, perhaps he could have proffered some advice, for he is obviously a thoughtful and intelligent author. As it is, he has written a fun, provocative, but ultimately very frustrating book.

It was disconcerting to find two "should be" allies in the creation/evolution pseudo-controversy apparently so far apart in their understanding of basic issues. In this Communication I argue that Gingerich and Johnson are closer to common understanding than the Gingerich review would indicate, and conclude by suggesting that they would both agree with ASA's resolution calling for teaching evolution *as science*.

I will address the issues raised by Gingerich in reverse order, first commenting on "how science functions," then dealing with Johnson's perception that the ASA writers of *Teaching Sciences in a Climate of Controversy* were "naive," and finally suggesting a solution to the practical problem of teaching evolution in the public schools.

How Science Works

Gingerich recently co-authored (with Alan Lightman) a landmark article entitled "When Do Anomalies Begin?" (*Science*, 255, pp. 690-695). The abstract reads as follows:

> An anomaly in science is an observed fact that is difficult to explain in terms of the existing conceptual framework. Anomalies often point to the inadequacy of the current theory and herald a new one. It is argued here that certain scientific anomalies are recognized as anomalies only after they are given compelling explanations within a new conceptual framework. Before this recognition, the peculiar facts are taken as given or are ignored in the old framework. Such a "retrorecognition" phenomenon reveals not only a significant feature of the process of scientific discovery but also an important aspect of human psychology.

In essence, the Gingerich/Lightman "retrorecognition" phenomenon observes that the majority of the scientific community is blind to anomalies in a reigning paradigm until "after they are given compelling explanations within a new conceptual framework." Anomalies are deviations from the expected or predicted natural order. They may be unquestioned, taken as givens, or "not widely regarded as important or legitimized until a good explanation is at hand in a new paradigm."

Gingerich and Lightman present five examples of the retrorecognition of anomalies following major paradigm shifts. As a geologist, my interest focused on the example titled "the continental-fit problem." Alfred Wegner, a German meteorologist, presented his case for continental drift in the early 1900s to explain the jigsaw puzzle fit of the continents. He marshaled additional supporting evidence (well recognized today) to prove that the continents were once together. Why it took over 50 years for the geosynclinal paradigm (which held to a largely horizontally static model) to be replaced by plate tectonics (which involves horizontal movement on a planetary scale) can be largely explained by the retrorecognition phenomenon. Geologists, schooled in geosynclinal theory, were incapable of recognizing anomalies, especially those that contradicted their reigning paradigm.

It should be noted the now largely forgotten geosynclinal theory was supposed to explain and pro-

vide a mechanism for the origin of major mountain systems. As recently as 1960, geologists thought that "just as the doctrine of evolution is universally accepted among biologists, so also the geosynclinal origin of the major mountain systems is an established principle in geology."[1] By the late 1960s it was obvious to most geologists that geosynclinal theory never *had* provided an explanation or established a mechanism for the origin of mountain systems.

Johnson's major point in *Darwin on Trial*, and in subsequent lectures and publications, is that Darwinists are so mesmerized by their paradigm that they cannot see anomalies or patterns of evidence at variance with their theory. For example, the fact that the Cambrian explosion of animal phyla and other macro-patterns in the fossil record contradict the predictions of the Darwinian mechanisms is unseen, ignored, or regarded as "details" to be squeezed into the existing framework. The 1990 California Science Framework bypasses these anomaly problems by limiting the format in which data can be presented to the Darwinian model: "The evolution of life should be presented to students not as a disconnected series but as a pattern of changing diversity united by evolutionary relationships...."[2] The message here clearly is that teachers should not present data independently of Darwinist interpretations.

Heeding this advice, in April 1990 the California Academy of Sciences opened a major exhibit at its Golden Gate Park Museum in San Francisco, entitled "Life Through Time: The Evidence for Evolution." While visiting the exhibit, I found that the most interesting display was one that showed fossils linked together in a way that was intended to show their evolutionary relationships. This display is diagrammed in Figure A (below left) with my empirical plot of the museum's data (copied from the fossil index on the adjoining wall) shown for contrast in Figure B (below right).[3]

There are several problems with this display, but three are particularly serious. First, in order to display the fossils in a way that is consistent with the Framework's recommendations, the creators took substantial liberties with the facts — by placing fossil specimens in the wrong geological strata. I have added the dates (in *mya*, or *million years ago*) for the oldest specimens to the diagrams to highlight the inaccurate placement of the fossils by the museum. The fact that the fossils are placed in the wrong strata in order to force them to fit the Darwinian paradigm is an apt illustration of the power of the Darwinian conceptual framework to inhibit scientific objectivity.

The second serious problem is the placement of magnifying glasses at every branch-point in the diagram. In all the other fossil displays in the exhibit, magnifying glasses were placed over minuscule fossils to help the museum-goers see them more easily. In this display, however, there are no fossils under any of the magnifying glasses. While this involves no misstatement of facts, it is still deceptive — lead-

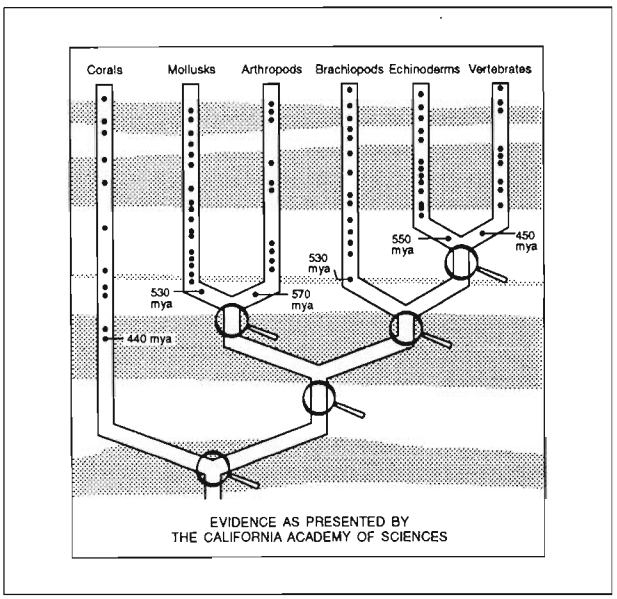

Figure A

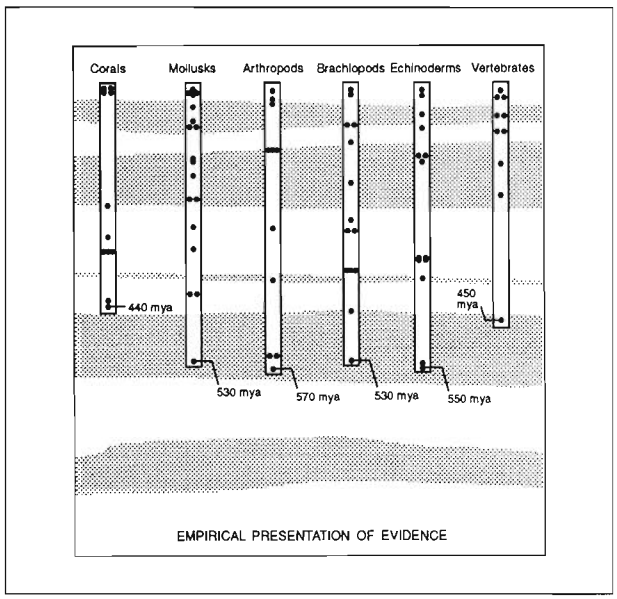

Figure B

ing the viewer to imagine that there are minute fossils at the branch-points, when there are none. Absence of evidence for evolution is artfully converted into evidence.

The lines connecting the taxa into the classic Darwinian evolutionary tree is the third and most serious problem with the museum display. The obvious objection to these connecting lines is that the title of the exhibit is "Life Through Time: Evidence for Evolution." Note that the connecting (ancestral?) lines and empty magnifying glasses at the points of hypothetical common ancestry are not *evidence* but *inference.*

This illustration of how museum curators have transformed inference into evidence and falsified the placement of fossils was presented by plenary speaker Phillip Johnson at the annual meeting of the Southwestern Anthropological Association (SWAA) in April 1992.[4] To my amazement, there was *no* reaction or comment from the audience. To me, the total blindness (or indifference) of the anthropologists may be explained by the Gingerich/Lightman retrorecognition phenomena. No matter how obvious distortions of evidence may appear, they are invisible or "ignored" by those steeped in the existing paradigm.

In any event, it appears to me that Johnson and Gingerich have the same understanding of how science works. They both know that science does not always work in the objective, open to skeptical criticism manner that we glorify in textbooks. It often works, as Gingerich has so aptly illustrated with his retrorecognition examples, in a way that can blind scientists to serious anomalies and evidentiary problems in entrenched paradigms. Johnson's skeptical approach may open enough eyes to bring the actuality of how science works closer to our ideal.

The Naivete of the ASA Writers

Let me assure the readers of this Journal that Johnson's comments on the "naivete" of the writers of the ASA booklet *Teaching Science in a Climate of Controversy* were accurate.[5] I was one of those writers. While we were correct in assuming that science teachers would welcome our contribution, we were naive to expect the same from the educational establishment. *Teaching Science* was (and still is) branded as "thinly disguised creation science" not to be used in the science classroom by the Manager of the California Math/Science/Environmental unit. Further, the *California Science Teachers' Journal* refused to publish our corrective response to a diatribe by William Benetta in its Spring 1987 issue.[6]

Gingerich, like Johnson, does not share our naivete. In fact, Gingerich prophetically states that "Johnson's brilliantly argued critique of Darwinian evolution is guaranteed to arouse exasperated irritation from those who accept evolution as an article of faith." Stephen J. Gould's highly critical four page book review on Johnson's *Darwin on Trial* in the July 1992 issue of *Scientific American* is an accurate fulfillment of that prophecy. Being more cynical and less naive than in the past, the ASA authors were not surprised that *Scientific American* refused to publish Johnson's response to Gould's attack. (Copies of Johnson's response are available from this author.)

Teaching Evolution in the Schools

Neither Johnson nor Gingerich want us to "abandon teaching evolution in schools, teach it as a scientific myth or give creationists equal time." To the best of my knowledge, they both affirm the solution outlined in the December 7, 1991 ASA's Executive Council's resolution "A Voice For Evolution *As Science,*" (see next page). In addition to carefully defining and consistently using the terms *evolution* and the *theory of evolution*, this resolution urges "(1) forceful presentation of well-established scientific data and conclusions; (2) clear distinction between evidence and inference; and (3) candid discussion of unsolved problems and open questions."

Let us not continue to be naive and expect that this ASA proposal is going to be implemented by the educational establishment. To date, our proposal has met with deflection, derision and hostility.[7] For those who desire to understand this hostility and the Darwinist control of education in the United States, I suggest reading *Darwin On Trial.* ☆

NOTES

[1] Clark, T.H. and Stern, C.W. (1960). *Geological Evolution of North America.* 2nd ed. (New York: The Ronald Press) page 83.

[2] *Science Framework for California Public Schools*, 1990, page 132. For further information and/or to order the *Framework*, see J. Wiester, "Teaching Evolution as Non-Science: Examples From California's 1990 *Science Framework*," *PSCF* 43:3, pages 190-192.

[3] For further information on The California Academy of Science Museum exhibit, see Hartwig, M. and Nelson, P.A. (1992). *Invitation to Conflict: A Retrospective Look At the California Science Framework.* (Access Research Network, P. O. Box 38069, Colorado Springs, CO 80937-8069) pages vi-x. As of August 1992, the museum display has not been corrected.

[4] Phillip E. Johnson's plenary paper entitled, "Darwinism's Rules of Reasoning" was distributed to the 100+ attendees at the SWAA Berkeley meeting and is available from this author. The two physical anthropologists responding to Johnson ig-

nored moderator Robert Anderson's admonitions and "squandered much of their allotted time on *ad hominem* arguments" (see Robert Anderson, "Evolution Versus Creation and the *Ad Hominem* Argument," Southwestern Anthropological Association Newsletter v. 33, no. 1, June 1991).

[5] Johnson, P. (1991). *Darwin On Trial*. (Washington: Regnery Gateway) pages 126-128.

[6] Copies of the relevant correspondence and articles can be obtained by contacting this author.

[7] The only response to the news coverage on ASA's resolution in *Science*, vol. 255, page 282, was by National Center for Science Education Director Eugenie Scott, which deflected the issue with the usual smoke screen (and I paraphrase) "teachers are afraid to teach evolution." Thomas H. Jukes referred to a similar proposal by this author to define terms and use them with consistency as "a venomous attack on scientists who have been fighting creationism" (*The Scientist*, Letters, April 29, 1991).

A VOICE FOR EVOLUTION AS SCIENCE

Background

Science teachers should stress the consistent use of precisely defined scientific terms. Otherwise, students cannot develop an accurate comprehension of scientific knowledge and practice.

Science teachers and scientists concerned about the future of science should (a) recognize the limited scope of science and resist exploitation of science by persons with political, philosophical, or religious agendas; and, while celebrating scientific accomplishments, (b) point out unsolved problems and encourage the investigation of such problems.

In its fiftieth year, the American Scientific Affiliation (ASA) of over two thousand scientifically trained members wishes to go on record in support of the above statements, through an appropriate resolution passed by the ASA Executive Council. As ASA members have explored both their engagement in scientific inquiry and their commitment to the Christian faith, many have sensed problems in the way biological evolution is taught in primary and secondary schools. Noting that at least two major court cases (*McLean v Arkansas Board of Education*, 1982; *Edwards v Aguillard*, 1987) have designated "scientific creationism" (or "creation science") as religious doctrine masquerading as science, the ASA judges it equally important to recognize "evolutionary naturalism" as another essentially religious doctrine masquerading as science. Evolutionary naturalism employs the scientific concept of evolution to promote an atheistic and materialistic view that nature is all there is.

In the current climate of controversy over science teaching in public schools, stretching the term *evolution* beyond its range of scientific usefulness promotes the establishment of evolutionary naturalism. Besides inviting reaction from proponents of scientific creationism, such careless usage also erodes support of sound science education among the broader population of theists, to the detriment of the whole scientific enterprise.

In "The Meanings of Evolution" (*American Scientist*, Vol. 70, pp. 529-31, Sept-Oct 1982) biologist Keith Stewart Thomson identified three commonly employed meanings of the term: (1) the general concept of "change over time"; (2) the hypothesis that all "organisms are related through common ancestry"; (3) a theory setting forth "a particular explanatory mechanism for the pattern and process" described in (1) and (2).

Other meanings range from (4) a scientifically focused concept of populations adapting to changing environments, to (5) a religiously value-laden tenet of naturalistic faith, that "Man is the result of a purposeless and natural process that did not have him in mind" (George Gaylord Simpson, *The Meaning of Evolution*, 1967, p. 345.). Science educators should not only distinguish among diverse meanings of evolution but point out that the degree of certainty rightfully associated with them varies widely.

Resolution: A Voice for Evolution *As Science*

On the basis of the considerations stated above, and after polling the membership on its views, the EXECUTIVE COUNCIL of the AMERICAN SCIENTIFIC AFFILIATION hereby directs the following RESOLUTION to public school teachers, administrators, school boards, and producers of elementary and secondary science textbooks or other educational materials:

BECAUSE it is our common desire to promote excellence and integrity in science education as well as in science; and

BECAUSE it is our common desire to bring to an end wasteful controversy generated by inappropriate entanglement of the scientific concept of evolution with political, philosophical, or religious perspectives;

WE STRONGLY URGE that, in science education, the terms *evolution* and *theory of evolution* should be carefully defined and used in a consistently scientific manner; and

WE FURTHER URGE that, to make classroom instruction more stimulating while guarding it against the intrusion of extra-scientific beliefs, the teaching of *any* scientific subject, including evolutionary biology, should include (1) forceful presentation of well-established scientific data and conclusions; (2) clear distinction between evidence and inference; and (3) candid discussion of unsolved problems and open questions.

(Text of Resolution Adopted by the Executive Council of the American Scientific Affiliation, December 7, 1991)

Further Reflections on *Darwin on Trial*

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For some of the ASA members attending the 1992 Annual Meeting in Kona, Hawaii, a highlight was a spontaneously organized discussion session following Phillip Johnson's paper. In the round-robin of correspondence that has ensued since the meeting, I realize that some of my own remarks at this session as well as my review of Johnson's *Darwin on Trial* (*PSCF*, June 1992) were not understood as clearly as I had hoped.

On one point there was unanimous agreement: the issue is *not* evolution versus creation. The issue is design versus accident.

Phillip Johnson has impressively documented the extent to which much evolutionary teaching comes with philosophical baggage claiming that "accident" is a real feature of the world, "proven" by evolutionary doctrine. In the time since Newton, science has used mechanistic explanations that dispense with divine intervention (the "God of the Gaps"), and with considerable success. To the extent that design represents divine intervention and "accident" does not, the later explanation can be invoked as part of a mechanistic explanation. All too frequently teachers in their naivete, or because of a deliberate atheistic orientation, present their material as if such a mechanism describes the actual world rather than being simply a rule of science.

Johnson and I both agree that the teaching must become more nuanced in its presentation, and we both reject evolutionism as a philosophy. But in my reading of Johnson, his strategy appears to invoke a frontal attack on evolution. I think this is misguided and ultimately fruitless. My brief is to launch the attack against the atheists who are using evolution to further their materialistic philosophies, against those who raise a reasonable structure of scientific explanation into a naturalistic ideology.

In an upcoming article ("Theistic Naturalism and The Blind Watchmaker," scheduled for the March 1993 issue of *First Things*) Johnson presents statistics to the effect that only a small minority of Americans accept the seemingly accidental, zig-zag pathways of evolution as being the wholly mechanistic way that brought intelligent life into existence. Part and parcel of Johnson's strategy is to define evolution in those terms, with the insinuation that anyone who thinks of evolution otherwise (in fact, the majority) is being duped. And, he maintains, the mechanisms that could build up the great chain of being, from microorganisms to fishes to mammals, are so flimsily and inadequately demonstrated that the whole structure should be dumped.

My counterstrategy would be to accept evolution as a reasonable theoretical structure for explaining a great many relationships in the biological world. It gives a very sensible explanation of why the DNA in yeast is so closely related to the DNA in human chromosomes, or why the genetic content of chimpanzees is so similar to those of *Homo sapiens*. It explains numerous morphological patterns from the coelocanth to the gorilla. It provides an insight into the many examples adduced by Darwin for imperfect adaptation. It helps us understand why Hawaii has so few species compared to the older continental areas, and why there would be flightless birds on the islands (now, alas, extinct since the recent introduction of such predators as the mongoose). Johnson's rejoinder is that distribution of species is not evolution. Of course not, and I never claimed so; but it is an excellent example of the sort of empirical evidence that remains mysterious and even capricious in the absence of some sort of explanatory structure, which the theory of evolution supplies.

The theory of evolution requires two basic elements: variation and selection. Darwin was greatly baffled as to how variation could arise, and his theory was rejected in many scientific quarters until a much greater understanding of genetics, and ultimately of the chemical basis of genetics, was achieved. There

still is no satisfactory detailed mechanism for producing large enough, non-lethal variation of the DNA to produce a new species in a single jump, and it remains an act of faith on the part of evolutionists that there is some way for it to have happened bit by bit. As a Christian theist, I believe that this is part of God's design. Whether God designed the universe at the outset so that the appropriate mechanisms could arise in the course of time, or whether God gives an occasional timely input is something that science, by its very nature, will probably never be able to fathom. But as a scientist, I accept evolution as the appropriate explanatory structure to guide research into the origins and affinities of the kingdoms of living organisms.

In closing my review of *Darwin on Trial*, I expressed my frustration by Johnson's apparent lack of appreciation about how science works, and this seems to be the least understood statement in my review. In Kona I tried to illustrate what I meant by mentioning Foucault's pendulum experiment, carried out in Paris on the night of 7-8 January 1851. The next morning there was not dancing in the streets because finally experimental proof for the earth's rotation had been found and that Copernicus was right. It was a marvelous demonstration, but Foucault's pendulum hardly affected the status of Newtonian theory or heliocentrism. It made no difference—people were already convinced about a rotating earth because Newtonian physics connected so many observations together into a coherent structure. I firmly believe that science concerns itself mostly with building coherent patterns of explanation, and rather little with proof. Lawyers seek proofs, and that's why I said that Phil Johnson was approaching science like a lawyer, somehow supposing that if he could show that evolution has no proofs, it would crumble. That, I think, is misguided.

In the discussion in Hawaii, John Wiester spoke well of the *Science* paper by Alan Lightman and me, in which we analyzed anomalies in science and the resistance of scientists to acknowledging them (*Science*, 255, pp. 690-695). But the essential, underlying thesis of the paper was that anomalies will generally pass unrecognized until the availability of an alternate theory in which they suddenly make sense. When I said above that Johnson's approach would probably be fruitless, I did so in this precise context. Until or unless there is another acceptable scientific explanation for the temporal and geographical distribution of plants and animals and their structural relationships, biological evolution will remain the working paradigm among scientists. To invoke God's active agency as the explaination for slow, long-term changes in the biological record will be no more efficacious as a scientific theory than to say that the moon orbits the earth or apples fall from trees because of God's sustaining activity in the universe. While I believe both to be true, they do not pass as scientific explanations. In reading *Darwin on Trial*, I am left with the impression that Johnson wishes they would. ☆

Theodicy and Evolution

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Many Christians have wondered at the role played by biological evolution in providing non-Christians a plausible way to escape from having to think of any form of creator to account for the origin of life. Having a construct such as biological evolution available disrupts otherwise neat world-views. As we struggle with this we may ask in all sincerity, "Why does God allow this? Would it not be a simpler, neater, cleaner and more compelling revelation if God, the Creator, had omitted biological evolution as a possibility in his creation?"

We may ask, "Why did God allow that?" But we must immediately ask the same question about a much more profound and difficult part of our experience ... "Why did God allow human suffering, why did God allow sin in his creation?"

This is the question known as "theodicy." It asks how a God who is holy, just, righteous, and omnipotent can allow sin and suffering in his presence, in a universe he created and sustains. Theologians have struggled with this difficult problem over the years. A rigorous analysis of the problem of evil and the attendant "free will argument" is found in *God and Other Minds*, by Alvin Plantinga.[1] At a more popular level, A.E. Wilder-Smith addresses just these concerns in his book, *Why Did God Allow It?*[2] Let us briefly outline his line of thought on these questions, then relate the result to a part of science.

We are troubled by those who claim to be atheists and do not realize that unless they are themselves omniscient, God *could* exist outside the limits of their knowledge. Thus their position of atheism is logically untenable. But we are much more deeply troubled by those who know and understand all of this, yet find that they must choose atheism because they cannot understand how a holy and loving God could allow sin and suffering. We cannot easily ignore their concerns.

Theologians recognize the difficulty of the problem posed by theodicy. A theological solution is based on the following components. God created the universe with a certain purpose. From the Bible we conclude that God put us in this universe, created in his image and thus having the attributes of his personality, including knowledge and will. God has chosen to give us the opportunity to recognize his existence, his greatness, our need of him, and his way of atonement and reconciliation. In particular, God does not force his will on us, he does not take away our choice in the matter.

So, we find ourselves unable to produce an air-tight proof of the existence of God, with which we may compel all to believe in him. We find deductive proofs and "sound" arguments of God's existence not available. But we do find sufficient *inductive* evidence of God's existence and presence to realize that he exists, that he is worthy of worship, and that we are in crying need of reconciliation to him and restoration of our broken lives.

The crucial point is that, while God reveals himself, God does not force us to believe in him — he does not make us into automata. But the fact that God chose to allow the possibility of a human choice *not* to believe in him led to sin, to suffering, to separation from God, to the incarnation and the suffering of Christ on Calvary, and to reconciliation in Christ. God was willing to pay a high price indeed to maintain our unrestrained possibility of choice!

When God takes a matter this seriously, we must also, and must seek to understand why. The answer lies in the fact that God gives us the opportunity for true love, the access to divine love, and the possibility of true worship. If there is no choice, there cannot be true love in its fullest sense. Though this question is approached differently in certain non-western cultures, the highest quality of love is only manifest when freedom of choice exists.

God's love is so far beyond human experience that to glimpse it we must understand human love in its highest form, then extrapolate. Divine love is

reflected by human love in the biblical illustration of bride and bridegroom. Love originates in a one-sided fashion, but must be reciprocated. If it is, true love can grow totally and completely, and the persons may entrust themselves to each other. Love is built on mutual respect and consent. That is, love has freedom as its basis — absolute free choice on the part of both partners. Wilder-Smith cites examples from the Old Testament of both freely chosen love and a disastrous attempt to achieve love by force.[3] What would be the result if God made us so that we could only obey his will? If we could not hate, could we truly love?

Thus absolutely free choice is a prerequisite for true love. God has chosen to give us divine love, and desires that we freely choose to love him. God does not force us to return his love, because to do so would destroy true love. Of God's own free will, he died to free us from guilt and re-establish fellowship, a costly love, and indeed truest love.

The conclusion is that God has chosen to place a very high value on preserving our free choice so that true love remains possible. This includes revealing himself in the way he has chosen. He has given us sufficient, even abundant evidence of his presence, but has not allowed us to lose the chance to say, "no," because with that we would lose the chance to love as well. If we could derive proof of God through science, thereby losing the choice to believe in God or not, we would be negating a fundamental purpose of God's creation.

How does this relate to science? The scientific method works extremely well within its limits. But its paradigm of *observation-hypothesis formation-prediction-experimental design-experimental testing*, plus repeatability of testing both in time and place, limits it severely in scope, and makes it less than fully applicable, if not inapplicable, when dealing with unique events. Scientists form conclusions by carefully applying scientifically acquired knowledge in making inference about such events, but this is not full application of the scientific method, and lacks the confidence in the hypothesis attainable from full application of the method.

In the light of the biblical doctrine of God as Creator and Sustainer, Christians receive the laws of science — and their continued regularity — from God, and find in them evidence of His faithfulness. If God were to disrupt that regularity in causing a unique event, properly understanding it would be outside the paradigm of the scientific method. It cannot be tested experimentally at other times and places. We would then appropriately call it a "miracle," in the narrow sense of the term.

Since the goal of science is to explain and understand all of this physical and biological universe that it can, science should be given its opportunity and be expected to seek understanding of any such event, but to do so within the scientific method.

We may understand God's action to be an intervention in the regularity of the universe in the case of a unique creative event. However, seeking only within the scientific method, scientists will attempt to give an explanation that does not include God. (Though in the complexity and beauty we as scientists find in the universe may make us stand in awe at the "miraculous" structure God has made, there are no miracles (in the narrow sense of the term) that are within science or to which the scientific method applies.)

There are Christians who wish to demand of science evidence for God and a rigorous proof for His existence. Scientists find abundant inductive evidence, but a rigorous proof is strictly lacking. If such a proof were forthcoming, then mankind would be compelled to accept the existence of (believe in) God.

This represents an unacceptable contradiction to what we have seen that theologians have found in the doctrine of free will and the role of evil in a universe that contains true freedom. God has gone to great lengths and tolerated much sin and suffering to assure our freedom and the true love that can result. So it is clearly a mistake to try to force science into giving us a derivation of God. This is not just because such is contrary to the paradigm and limitations of the scientific method, but because God, in His wisdom, has chosen a plan for the universe that precludes it.

To take a specific example, those Christians who would devote their time and effort only to "refuting evolution," should consider the implications of these limits. Divinely implemented explanations are ruled out by the limitations of science. Scientists will form their best possible hypotheses within the rules of science. To explain life from non-life in an "evolutionary" fashion is the most accepted of these hypotheses, while intervention by an advanced civilization with space travel is another. A scientific method that, by its epistemological paradigm, excludes the possibility of finding God should be expected (allowed) to work only within its realm and not be condemned for not finding God. Were it ever able to derive the necessity for God, it would just have defeated God's purpose in allowing free will. From theodicy we can also now see why God has not given us some other "scientific" paradigm that includes him.

Why does God allow such an idea as evolution? God allows sin and suffering, within the purpose of his creation, in order to make possible true love. As a result of this choice, God bore the suffering of all mankind! Similarly, to allow true freedom and true love, God also allows a system such as evolution to exist, free of the requirement of God's existence, as necessary in order to preserve that same purpose of creation, free choice, true love. Then let us concentrate on God's great love, on God's great love as demonstrated in his suffering for us. And let us concentrate on appreciating the greatness of God as revealed by science, by revelation, and by our personal reconciliation to fellowship with him. Rather than making our primary effort the arguing of the details of the relationship of various versions of evolution to various understandings of creation, let us first acknowledge the subservient nature of all these constructs to God's greater plan to reveal himself and extend his true love to mankind. Then we can move a step closer to full appreciation of God and to true worship. ☆

NOTES

[1] Alvin Plantinga, *God and Other Minds*, Cornell University Press, (1967, 1990).
[2] A.E. Wilder-Smith, *Why Did God Allow It?*, Master Books, San Diego, (1980).
[3] See note 2. See also Genesis 24:58, II Samuel 13.

A Promising Beginning: A Report on the First Pascal Centre Conference on Science and Belief

Over 130 participants from 8 nations gathered at Redeemer College in August to lay the groundwork for what the planners identified as an attack on the compromising legacy of secularism in placing a wall of separation between Christian faith and a scientific understanding of the world. Pascal Centre director and co-program chair Jitse Vandermeer and a capable staff provided excellent accommodations and a meeting format which effectively integrated keynote addresses and small workshop sessions on specific themes. The conference focused on various relations between religious belief in God (faith), conceptual beliefs about God (including theology) and conceptual beliefs about the world (including science). The various sessions reviewed the current status of these relations and sought to identify basic questions for future study.

One was aware of strong philosophical and historical emphases with theology less prominent but always undergirding the discussions.

Working scientists were under represented, and one observer noted the lack of overall relevance of the program for the working scientist, a common note at conferences of this sort. The implication is that we can begin to deal with the real world once the ideal world is sorted out.

While the predominant accent was Dutch, Scottish brogue and the tones of Philadelphia, New England, mid-America and the regions beyond guaranteed a good mix of ideas and a chance to build friendships with those previously known only through their work. ASA and CSCA members played prominent roles.

Something of the flavor of the meeting can be gained from a sampling of paper titles and speakers: "Religious Belief and the Natural Sciences: Mapping the Historical Landscape" (John Brooke); "The Transcendental Role of Wisdom in Science" (Thomas Torrance); "Scientific Work and Its Theological Dimensions: Towards a Theology of Natural Science" (Christopher Kaiser); "The Mediating Role of Metaphor and Analogy in the Relationship Between Science and Religion" (Elaine Bothe); "On the Very Possibility of Intelligent Design" (William Dembski); "Newton and Christianity" (Samuel Westfall); and "Control Hierarchies: A View of Life" (David Wilcox).

One welcome emphasis of the conference was the ample opportunity for discussion and rebuttal. There were no sacred cows. Availability of papers before the meeting allowed the participants to prepare for the workshop sessions. The last day of the conference offered the chance to gain an overview of what had been accomplished and identify topics for future conferences. This sort of "summing up" and "future directions" is a welcome change fromthe inclusive endings of many science/faith meetings. Many of the papers will be included in a two volume *Proceedings* due to appear in 1993.

Frustrations with occasional participant longwindedness, moderator lapses and scheduling conflicts did not dampen enthusiasm. Discussion were often spirited as sharp differences emerged, yet a sense of purpose kept a divisive spirit from emerging.

Participants left with an overload of ideas to mull over and incorporate in their own thought, while Pascal Centre planners turned to editing the papers and planning the next phase of their task. This was indeed an impressive beginning.

J.W. Haas, Jr.

Dialogue

On Rejecting The Theory of Common Ancestry: A Reply to Hasker

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I wish to respond to William Hasker's "Evolution and Alvin Plantinga" (*Perspectives on Science and Christian Faith*, Sept. 1992, pp. 150 ff.).[1] Hasker takes issue with several things I said; I am tempted to engage in lengthy point-by-point self-exculpation, but I shall resist, confining myself to a couple of points of general interest. Some of the issues involved seem to me to be extremely important with respect to the health and welfare of the Christian intellectual community.

First, however, just a bit of stage setting. My original article ("When Faith and Reason Clash: Evolution and the Bible"[2]) was devoted to this question: what should Christians do when there is an apparent conflict between faith and reason? I took as an example the apparent conflict between the teachings of Christianity and the teachings of current evolutionary theory; and I noted that many of the experts (Ayala, Dawkins, Gould, Ruse, Simpson, Spieth, e.g.) claim that evolution is certain, as certain as that the earth revolves around the sun. (By "evolution" they apparently mean at least TCA: the theory of common ancestry, the theory according to which all contemporary living things are genetically related.) I disputed these claims of certainty and suggested that they should be explained in terms of the fact that evolution is the only naturalistic explanation available, the only game in town. I went on to argue that the probability — or acceptability — of TCA is much lower with respect to Christian theism and the empirical evidence than with respect to philosophical naturalism and the empirical evidence. Indeed, I claimed that TCA is improbable, less probable than its denial, with respect to theism and the empirical evidence. And I did this without saying exactly how I think God *did* create all the varying forms of life, without specifying and endorsing some hypothesis of the same logical level or the same logical strength as TCA.

Now both Ernan McMullin[3] and Hasker apparently think there is something improper with this procedure. Both apparently believe that if you reject a theory or explanation as unlikely on the evidence, you have to be prepared to propose some other theory in its place. They don't say what you must propose this theory as, or claim for it: must you think it is true? Or (less stringently) more likely than not? Or (still less stringently) more probable than the one you reject? All three of these alternatives, I believe, are importantly mistaken; and because this is such an important point, I want to look into it more carefully.

Hasker first suggests that "Plantinga is gaining an unfair advantage by pointing out the weaknesses of a hypothesis he opposes, while leaving his own view in the dark and thus safe from criticism" (p. 154), and in a footnote he adds that even if I didn't intend to gain an unfair advantage in this way, the fact is I *did* gain an unfair advantage for my view by not putting it out for criticism. Of course this presupposes that I *have* a view here. And I *do* have a view: that the probability of TCA with respect to Christian theism and the empirical evidence is low, lower than that of its denial. But Hasker apparently believes that if I reject TCA as improbable, then (if I am proceeding properly) I must be prepared to suggest and endorse some other view of the same

specificity or same logical strength as TCA. Now at first glance, anyway, that seems wrong. I think Cardinal X will be the next Pope; you think that is unlikely, but don't have a candidate of your own; there is no one such that you think it is more likely than not that he will be the next pope. Is there something wrong with your procedure? I think not.

A fuller example: you are at the race track. There are 8 horses in the first race. These horses are fairly evenly matched, but there is a favorite, Black Beauty, who you think has a ⅓ chance of winning. You leave just before the end of the first race; as you leave you hear a roar go up from the crowd. The most probable explanation, as you see it, is that the crowd is cheering Black Beauty, who has just won the race. Will you *believe* that explanation? I hope not; although there is a ⅓ chance that Black Beauty is the winner, there is a ⅔ chance that she isn't. Do you instead believe of some *other* horse that *it* is the winner? No: each of them, as you see it, has a smaller chance of winning than Black Beauty. Is there anything irrational or methodologically unsound in this structure of belief? Again, I should think not.[4]

But doesn't the same structure hold for explanations more generally, including scientific explanations? If you think a given explanation or theory **T** is less likely than its denial, or even if you think it is only somewhat more likely than its denial, you quite properly won't believe it. This is so even if you can't think of another theory or explanation of the phenomena that you believe more probable than not, or even more probable than **T**. (I take it the denial of a theory isn't automatically another theory.) In the horse race example, I reject (do not believe) the proposition that Black Beauty won (although of course I also reject the belief that she lost); I know of several other theories of the same level of generality as that Black Beauty won: but I don't believe any of them; and, in fact, each of them is less probable, as I see it, than the hypothesis that Black Beauty won. So it is sometimes perfectly sensible to reject the best (or most probable) explanation. This might be when you don't know of any other possible explanations at all; but the same thing is also perfectly rational when you do, if all of them including the one in question are too unlikely.[5]

This is how things look on the face of it; but Hasker believes these appearances are misleading. He claims that I can't justifiably think or say that TCA is unlikely on the evidence unless I am prepared to come up with an alternative to it; and he has an argument for that conclusion. I want to look at his reasoning here, and I beg the reader's indulgence for descent into the sort of line by line analysis that analytic philosophy is infamous for. But let me first briefly recap the discussion. In the original article I said that the similarity in the biochemistry of the various forms of life is reasonably probable on the hypothesis of special creation and hence not much by way of evidence against it. Now the hypothesis of special creation I had in mind was just the hypothesis that

> **SC:** God created at least some forms of life specially, in a way that did not involve common descent.

I thought (and still think) that the given biochemical similarity between the various forms of life is not improbable on SC: we have no reason to think that if God created some forms of life specially, he would do so in a way excluding this similarity. But if that is so, then it is easy to see (via an application of Bayes' Theorem that I won't trouble you with) that biochemical similarity isn't strong evidence against SC; and if *that* is so, then it is not strong evidence *for* any view incompatible with SC, such as TCA.

SC, of course, isn't really an alternative to TCA; it says just that God has created life in some way incompatible with TCA, but it doesn't venture a guess as to what way that might be. (SC is equivalent to the conjunction of the negation of TCA with the proposition that God has created the various forms of life (in some way or other).) And Hasker believes that I must have or endorse a proposition more specific than that, something of the same logical strength as TCA, if I am justifiably to reject TCA as less likely than its denial on the relevant evidence? Why so?

> The place where the need for an alternative shows itself is when Plantinga undertakes to assess the empirical evidence adduced in support of TCA. He says of one strand of evidence, "[It is] reasonably probable on the hypothesis of special creation, hence not much by way of evidence against it, hence not much by way of evidence for evolution" . . . . The burning question here is the one already posed by McMullin: *"Which thesis is more probable than TCA?"*
>
> What particular hypothesis does Plantinga have in view, so as to be able to say that the evidence is "reasonably probable" on *that* hypothesis? Here it clearly will *not* do to say that the hypothesis in question is simply the denial of TCA. For TCA is a fairly *strong* hypothesis, and its denial is correspondingly weak in its logical force—that is to say, it is compatible with an enormous range of alternatives, and the alleged evidence for evolution may be extremely probable with respect to some of these alternatives and extremely improbable with respect to others (p. 155).

Why can't I rightly use SC in arguing that TCA is improbable? I think Hasker's answer is given in what he says about the denial of TCA: it will not

do, Hasker thinks, to say that the hypothesis in question is just the denial of TCA. Why not? Because TCA is a strong hypothesis, and its denial is correspondingly weak. Why is that a reason for saying that the denial of TCA 'won't do'—i.e., can't properly be used in an assessment of TCA of the sort I was proposing? It won't do, says Hasker, because "it is compatible with an enormous range of alternatives, and the alleged evidence for evolution may be extremely probable with respect to some of these alternatives and extremely improbable with respect to others." And I think Hasker would say the very same thing about SC; it too won't do in that context; it too is such that I can't properly argue that the biochemical similarity is reasonably probable on it, so that the biochemical similarity is not strong evidence against it, and is hence not strong evidence for any proposition incompatible with it. As in the case of the denial of TCA, the reason SC can't be used in such an argument is that there are a large number of more specific alternatives compatible with SC — there are many ways in which God might have created life, compatible with SC — and on some of these alternatives the biochemical similarity will be probable, while on others improbable. That seems right; but how exactly is it relevant? Hasker doesn't say; but what he says suggests that perhaps he thinks that as a result, either the biological similarity won't *have* a probability, on that evidence, or at any rate if it *does*, we can't make a decent stab at estimating it.

But this seems to me mistaken. SC is compatible with an enormous range of alternatives, on some of which the alleged evidence (the biochemical similarity) is very probable and on some of which it is very improbable: true enough. Indeed, some of those alternatives *logically entail* that evidence, and others logically entail the denial of that evidence. But why think this means either that the evidence doesn't have any probability on SC or that we can't make a reasonable estimate of what it is? After all, *any* pair of propositions **A** and **B** such that **A** doesn't logically entail **B** are related in that way, and in many of those cases we can make a very good estimate of the probability of **B** on **A**.

Consider, for example,

> (1) Nine-tenths of all Mormons live in Utah and Brigham is a Mormon;

and

> (2) Brigham lives in Utah.

I suppose most of us would agree that (2) has a probability on (1) and that we can at least make a sensible estimate of that probability. But (1) is compatible with a large number of alternatives; it is probable with respect to some of these and very improbable with respect to others. For example, (2) is very improbable with respect to

> (3) Brigham is a policeman in Tucson, and hardly any policemen in Tucson live in Utah;

which is compatible with (1), or even

> (4) Brigham is an Oxford don and lives in North Oxford;

which is compatible with (1) and entails the denial of (2). On the other hand, (2) is very probable with respect to

> (5) Brigham is an insurance adjuster in Salt Lake City and nearly all insurance adjusters in Salt Lake City live in Utah;

which is compatible with (1), or even

> (6) Brigham is an insurance adjuster who lives in Salt Lake City;

which is compatible with (1) and entails (2).

I therefore do not see the force of Hasker's argument for the conclusion that I can't properly use SC in my argument for the conclusion that the biochemical similarity of life is not strong evidence for TCA.

Hasker is reasoning as follows. I say that biochemical similarity is reasonably probable on SC and hence isn't strong evidence for any proposition incompatible with SC, that TCA is incompatible with SC, and that therefore biochemical similarity is not strong evidence for TCA. So I am choosing a certain proposition (SC) and using it to argue that biochemical similarity isn't strong evidence for TCA by pointing out that SC is incompatible with TCA and that the similarity in question is reasonably probable on SC. Now I think Hasker believes that the only sort of proposition that can properly play the role of SC in an argument like that is one that is as *detailed and specific* (or maybe nearly as detailed and specific) as is TCA itself. (Or perhaps the idea is that such a proposition must have as much content as TCA itself.) And this is why he thinks that if I can properly reject TCA (in the sense of holding that it is less probable than its denial) then I must be prepared to produce some proposition that is as specific as TCA or has as much content as it does, and which I think is more probable, on the relevant evidence, than TCA is. But this is incorrect, for the reasons given. I am of course committed to thinking there

is some other hypothesis of equal strength that is *true*; but it doesn't follow that there is some other hypothesis of equal strength that is *more probable on my evidence*. (And even if such a hypothesis is more probable on my evidence, it doesn't follow that I know of it.)

If you claim that evolution is improbable, on the evidence (and as a consequence do not accept (believe) it), people often ask you what your alternative is, the idea being that you should be embarrassed if you don't have a good alternative. As we have seen, the question is really illegitimate; one perfectly sensible stance is agnosticism. But isn't there a common sense truth lurking somewhere in the neighborhood of that request?

Perhaps so, and perhaps it goes something like this. In the context of a scientific investigation, you need *some* hypothesis, perhaps only a working hypothesis, to guide your inquiry, to enable you to decide what to do next, where to invest your limited resources of time and energy and perhaps money. TCA seems to be a fertile source of such guidance. If you reject it and someone asks what the alternative is, they may be asking what hypothesis you propose to perform that function. And if all you can say is "Well, God somehow did it in a way incompatible with TCA" then you don't have much by way of a substitute. So SC doesn't perform that function at all well.

But of course it doesn't follow that if you can't think of a hypothesis inconsistent with TCA that has as much content and is more probable on the relevant evidence, then you can't properly think that TCA is improbable on that evidence. Hasker says

> ... when Plantinga says that the evidence of evolution is reasonably probable on some alternative to the evolutionary hypothesis, we have no way of knowing, in sufficient detail, what that alternative is; thus we are unable even to *formulate the proposition* which we would need to evaluate in order to determine whether Plantinga's claims are warranted (p. 156).

Just here is where we disagree: it seems to me that I can know perfectly well that evolution is unlikely with respect to the evidence even if I don't formulate and endorse any propositions at all that are at the same level of strength or specificity as TCA.

By way of conclusion, four quick comments on other matters. First, McMullin objects to my proposal that Christians should practice science from a Christian perspective; he says that such science will not be *universal*. I replied that science, "if practiced in such a way as to honor the methodological naturalism that McMullin urges is by no means always universal" (p. 98), and I offered as an example Herbert Simon's conclusion that the explanation of the altruism of Mother Teresa, and others, is to be seen in "bounded rationality" and docility. Here Hasker says I missed the point:

> Sociobiology *is* universal, not in the sense that its *conclusions* are acceptable to everyone, but in that its *methods* are open to all: anyone, be he Hindu, agnostic or Calvinist, can pursue the empirical and conceptual inquiries which will validate or refute sociobiology's claims (pp. 158-159).

The suggestion seems to be that anyone can practice or work at sociobiology, even if they do not accept its conclusions, i.e., the explanations it gives of, say, Mother Teresa's altruism. That seems right; but in *that* sense, theistic science, as I was thinking of it, is *also* universal. Its aim is to see how best to explain the phenomena from a theistic perspective; anyone (Hindu, agnostic, or Calvinist) can take part in this enterprise. The conclusions of theistic science may not be *accepted* by non-theists, but the method—trying to see how best to explain the relevant phenomena from a theistic perspective—is indeed open to all.

Second, I say that so far as I can tell (and I am surely no expert) TCA is less likely than its denial on the empirical evidence together with theism, specifically leaving out of account what the Lord intends to teach us in early Genesis. Hasker points out (p. 154) that I may be wrong here, and in particular may be subconsciously importing my beliefs about these matters into my evaluation of the probabilities. Well, yes, of course that's possible; in spite of our best efforts we can't be sure that we aren't influenced, in forming a given belief, by extraneous considerations. I suppose Hasker would concede that he too, in evaluating my arguments, could be subtly and unhappily influenced by his acceptance of the main lines of evolution. All we can do is the best we can do.

But the real question isn't how *I* evaluate that probability: I instead invite *you* to evaluate it. Consider the fossil record and the pattern of sudden appearance and stasis it presents (and the absence of intermediates between the really large groups, such as unicellular life and the Cambrian explosion, between fish and amphibia, reptiles and mammals, reptiles and birds, and the like); consider such vexed questions as whether it is even biologically possible that whales, say, could have developed from some early form of terrestrial mammal, or that eyes or

brains could have developed by way of any mechanism so far suggested; consider the fact that our only direct evidence is limited to such things as the directed production of new species of fruit flies from old; consider the fact that God could perfectly well have created various kinds of creatures without recourse to universal common ancestry; and then ask yourself whether TCA is more likely than not on all this. (Of course the question is not whether at least some evolution, even very extensive evolution has occurred; the question whether *all* creatures are related by common descent.) It seems to me that the answer is reasonably obvious. But of course what I hope is that Christian biologists, people who know a great deal more than I do about the evidence, will evaluate TCA from this perspective, unbuffaloed by all those claims of certainty trumpeted by the scientific establishment, and undaunted by the opprobrium visited upon those who dare to dissent.

Third, Hasker reminds us of Barr's claim that the author(s) of Genesis intended to teach a literal six day creation, a young age for the earth, and a worldwide flood. Says Hasker:

> ... Barr's view is absolutely devastating for those who, like Plantinga, hold that the creation story is relevant for deciding on scientific views to be accepted by contemporary Christians. If Barr is right, Plantinga's choices would seem to be stark: Either accept an uncompromising version of Creation Science, or admit the Genesis account is *not* relevant to our acceptance of scientific views about origins (p. 159-160).

Now first, I should have made it clear that I am not convinced that Barr is right in thinking the authors of Genesis did indeed mean to teach a literal six day creation and a young earth. Barr says so, and of course what he says is not to be taken lightly; but other experts disagree, claiming that the form of discourse involved is more like that of (say) a parable, rather than one whose aim is the sober, literal truth. I'm not sure who's right. If Barr *is* right, however, my response, as Hasker notes, would be that the ultimate author of Scripture is God, and it isn't necessarily the case that what God intends to teach is the very same thing as what the human author had in mind; he then points out that this introduces a gap between what the human authors of Scripture had in mind and what God intends to teach, and adds I haven't given any general directions for crossing that gap.

Of course I haven't; I doubt that there *are* any general directions for crossing it. But the principle that God is the ultimate author of Scripture and that what the human author(s) have in mind may not be identical with what the Lord intends to teach us (of course he may intend to teach people at different historical epochs somewhat different things) was accepted both by Thomas Aquinas and John Calvin (as well as a thousand other Christian thinkers); and anything accepted by both Aquinas and Calvin must be taken very seriously! Indeed, wouldn't *anyone* who accepts anything at all like a traditional view of God's revelation in Scripture agree that the ultimate author of Scripture is the Lord? And that in at least some cases (Old Testament prefigurations of Christ, e.g.) what the Lord intends to teach is not the same thing as what the human author(s) had in mind? True, that can make for difficulties in some cases; we won't always be sure just what it is that the Lord *is* intending to teach in, say, a given passage of the Bible. But that is scarcely news. And is it any easier (consider the prodigious vagaries of contemporary Scripture scholarship) to discover what the human authors *did* have in mind. All we can do is the best we can do; the difficulties Hasker points to are indeed genuine, but they are difficulties for everyone. It isn't as if we know of some course here not subject to difficulty.

Finally, Hasker points out that my suggestion (that Christians should assess and practice science from a theistic or Christian perspective) has its dangers, among them being that "the theological disciplines will assert hegemony and, supported by the ecclesiastical authorities, will attempt to 'call the shots' for the 'lesser' secular disciples" (p. 159). Hasker is right, of course: this course (like any serious enterprise) has its dangers. But again, so does the alternative; and I believe that *those* dangers—failing to discern the patterns and currents of spiritual and intellectual allegiances of contemporary culture, intellectual compartmentalization, failing to lead all of life captive to Christ, being conformed to this world—are even worse.

Hasker concludes by claiming that those who attempt to construct a Christian or theistic alternative to contemporary science—psychology and sociology, presumably, as well as physics and chemistry—will

> at best, . . . discover fifty years too late, that the Bible does not "clearly teach" about science what their grandfathers said it did, and that the scientific knowledge their grandfathers rejected should indeed, albeit tardily, be welcomed as true insight into the structure of God's creation. Those who forget history are doomed to repeat it (p. 160).

That is of course a possibility, and another danger lurks here (although I very much doubt that our

grandchildren will conclude that, for example, sociobiological explanations *a la* Simon of love and humor and altruism are to be welcomed as true insights into the structure of God's creation). We always run the risk of being wrong, even whoppingly wrong, and in fact often *are* wrong. Of course, it isn't only Christian thought about science that runs this risk; the same goes, obviously, for science itself. Consider 19th century physics: the centerpiece of science, the pride of the Enlightenment, widely considered the apotheosis of human intellectual achievement. At the end of the nineteenth century it was thought that we human beings had pretty much figured out the basic structure and lineaments of the universe; perhaps there were a few loose ends here and there to tie up, but the job was fundamentally done. From our present perspective this is deeply mistaken, and it can also seem to display a sort of touching ingenuousness. Life (including the life of the mind) is a pretty tough proposition.

So we run a risk; but of course the right conclusion is neither that we should ignore these Augustinian questions, nor that we should automatically assume that if the experts say it, we can't properly object to it from a Christian perspective. Nor can we just assume that Christian theism is irrelevant to the sciences. Clearly, for example, TCA *is* much more probable from a naturalistic than a theistic perspective, and I don't think Hasker means to deny that. Clearly much of contemporary science, in particular contemporary human science such as psychology, economics, and sociology, is deeply inimical to Christian theism. Christian scholars must recognize these things; we should try to see exactly how this antagonism goes, what its limits are, where the antagonism is sharpest, where it is most subtle and dangerous, and so on; and the resulting insight must be made available to the Christian community. And suppose there are serious shortcomings, from a Christian perspective, in the way in which one or another discipline (or parts of one or another discipline) is currently practiced and pursued: then Christians should try to do it better. ☆

NOTES

[1] Hasker's paper is a comment on a discussion in the September, 1991 issue of the *Christian Scholar's Review*. This discussion begins with my "When Faith and Reason Clash: Evolution and the Bible," continues with responses to that piece by Howard Van Till ("When Faith and Reason Cooperate"), Pattle Pun ("Response to Professor Plantinga") and Ernan McMullin ("Plantinga's Defense of Special Creation") and concludes with my "Evolution, Neutrality, and Antecedent Probability: a Reply to Van Till and McMullin."

[2] See note 1.

[3] "Plantinga's Defense of Special Creation," p. 72. McMullin also criticizes Michael Denton (*Evolution: a Theory in Crisis*, Bethesda, MD: Adler and Adler, 1986) for rejecting TCA but failing to suggest an alternative: "But he assumes that he has also refuted TCA, while providing no hint himself as to how the correspondences he finds so remarkable might be explained by something *other* than common ancestry." (p. 68, footnote).

[4] I filched this example from Bas Van Fraassen: see his *Laws and Symmetry* (Oxford: Oxford University Press, 1989) p. 149).

[5] Hasker cites some contemporary philosophers of science, who point out that one should sometimes accept a theory even if it "fails to conform to all the known data in the field under study." But surely these philosophers do not mean to say that we should *believe* a theory that is logically inconsistent with known data; that would be peculiar counsel indeed. Nor are they suggesting that we should evaluate such a theory as *probably true*, even if it is incompatible with what we know. Rather, their counsel, I take it, is that such a theory can nonetheless quite properly be *accepted*, in a sense that does not entail belief. (Thus we might think the theory is in the *neighborhood* of the truth, even if as it stands it is clearly false; or we might think it promising enough to be taken as a basis for further work, as a source of illuminating and worthwhile questions.)

Here Hasker says he thinks it is possible to detect the influence of Bas Van Fraassen's anti-realism. Although I greatly admire Van Fraassen and his work, I do not accept his anti-realism, which in any event is limited to the realm of the unobservable (the world of quark and gluon, etc.) and does not carry over to theories like TCA.

[6] According to Hasker (p. 155 bottom second column),

> ... it simply is not true that Plantinga is committed only to the negation of TCA. It is quite clear from various things he says, that his view is at least that "God did something special in creating initial forms of life, then something special in creating some other forms of life, then something special in creating human beings."

Here Hasker and I aren't quite communicating. Just for the record, I am *not* committed to the negation of TCA; all I say is that I think TCA is *less likely* than its negation. But of course that doesn't mean that I *believe* or am committed to its negation. In the Black Beauty case, I believe it unlikely that Black Beauty won; but I am not committed to the proposition that she didn't. (Failing to believe a proposition is of course not the same as believing its denial.) Second, I am also not committed to the proposition that "God did something special in creating initial forms of life, then something special in creating some other forms of life, then something special in creating human beings" (though I do think it more probable than not). What I said in the passage Hasker quotes is that I thought this proposition *more probable*, on theism and the empirical evidence, than TCA. But again, that doesn't mean that I am *committed* to it.

Book Reviews

BEYOND THE BLUE HORIZON: Myths and Legends of the Sun, Moon, Stars, and Planets by Edwin C. Krupp. New York, NY: HarperCollins Publishers, 1991. x + 387 pages, index. Hardcover; $35.00.

People have used the heavens for many things: from predicting the time for planting crops to Columbus' use of his knowledge of an impending eclipse to flim-flam New World natives. If you own a Suburu, Krupp will tell you the inspiration for the name and emblem of your favorite car. The heavens provide the setting for explanations of the origin of the world; the reason and calendar for changing seasons; and the inspiration for music, human sacrifice, and modern fiction. Mozart's *The Magic Flute* is cited as an example of how mankind has only "repackaged" the ancient myths. The whole area of current quasi-occult to occult excitement, from UFO phenomena to the New Age movement and its recent experiment in harmonic convergence, are portrayed as merely the modern terminus of the age old mythmaking-in-the-sky habit. Quite a variety! Incidently, Krupp has bad news for the New Age; the Age of Aquarius is still six centuries in the future (p. 129).

Krupp does not state a purpose for his book, but it is obviously an outgrowth of his abiding interest in educating the public about astronomy and its relevance to the human story. It may well be summed up in the following quote: "The path we were walking at Laetoli, in Tanzania, where we left footprints in the ash 3.7 million years ago, has taken us to the moon" (p. 341).

Beyond the Blue Horizon is well produced; it is lavishly illustrated with clear photographs, well-done line drawings, and even Gustave Dore engravings. There is a mammoth, classified bibliography of nearly 33 pages and also a detailed index. The volume is well bound in large (8 x 10) format with two columns of print per page. It is inevitable that this breadth of scope and style, suitable for a popular but educated audience, must lead to a somewhat cursory and introductory treatment. However, the quality of coverage is quite good for a book of this nature, and those whose curiosity has been whetted can refer to the extensive classified bibliography.

The book is not a collection of myths from over the world; neither is it a detailed analysis of any of the myths. Although a few myths are retold in some detail, most are mined for use as illustrations to specific points in his overview. He devotes separate chapters to expositions of specific topics such as mythology of beginnings, the moon, the rainbow, the morning star, and Christmas traditions.

Myth is never given a formal definition, but Krupp does provide a helpful discussion of the meaning, purpose, and origin of myth, comparing it to the structure of thought and to myth's relationship with science and metaphor. He opens the chapter with a brief discussion of the use of storytelling to give relationships in both science and myth.

The comprehensive nature of a book that ties the mythology of widely disparate cultures over the entire earth together into common themes and approaches intelligible to non-specialists, a well-written and illustrated narrative, and the undoubted authority of the author will commend this book to many people. E.C. Krupp is an internationally recognized authority in prehistoric and ancient astronomy, the Director of the Giffith Observatory in Los Angeles, and author of a number of books. The American Institute of Physics has awarded prizes to two of his books, and the Astronomical Society of the Pacific awarded him the Klumpke-Roberts Award in 1989 "for outstanding contributions to public understanding and appreciation of astronomy."

Although there are a few brief passages relating to Christianity and Biblical cultures, such as the brief paragraph on page 20 expounding on why traditionalists and fundamentalists "object to scientific scrutiny of the origins of homo sapiens *(sic)* and the world," a decision to read or purchase this book must be made solely on the basis of interest in ancient (or recent!) sky mythology and folklore.

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CAN SCIENTISTS BELIEVE? Some Examples of the Attitude of Scientists to Religion by Nevill Mott (ed.). London: James, 1991. 182 + vi pages. Hardcover.

The book is a collection of articles written by fifteen scientists from different parts of the world and from different religions, including one unbeliever. All these articles in a more or less explicit way attempt to substantiate one of two opposing claims: *a scientist can be a believer*, or *a scientist cannot be a believer*. Most of the answers revolve around the former position. However, the ways of answering this question range between reducing religion to an insignificant phenomenon having very little to do with science on one hand and giving religion and faith priority over science on the other.

The scientists who wrote the articles in this book come from different disciplines and they try to throw some light on the problem of religious beliefs using arguments stemming from their disciplines. For instance, D.J. Bartholomew, a statistician, points out that an existence

of real randomness in the world is in no conflict with God's working; he also shows the absurdity of M. Minsky's claim that the mind is a product of random accidents in the brain. P.E. Hodgson, a nuclear physicist, mentions "the debilitating effects of the Copenhagen philosophy of quantum mechanics" exemplifying views which being "inimical to theism are also ultimately destructive to science itself" (p. 72). John Eccles, a neurologist, argues in his technical paper for the thesis that "the religious concept of the soul achieves recognition in the new concept of mental units or psychons" (p. 97). John J. McGlone, an animal scientist, remarks that in science most of what we know has to be taken by faith, and a believing scientist "feels sanctification from knowing God has designed" the wonders of nature (p. 158).

Most of these scientists present their views in a humble way — admitting that the world is much too complex to be known fully and the knowledge of God cannot be fully attained in this world — probably with the exception of the editor of the book, Nevill Mott, who says he is "repelled by the element of the miraculous which forms part of Christian doctrine." Thus, in Bultmann's demythologizing spirit he rejects the basic elements of this doctrine. Virgin birth and resurrection are but fables, sacrifice for sins is meaningless, God's statement, "and it was good," is hollow, an omnipotent God is to him like "a tribal god." God is needed to him only to give meaning to the mystery of human consciousness, this mystery that cannot be explained by science he admires so deeply. Otherwise, God is not needed. In this we may see a return to the old doctrine of gnostics who admitted only what they were able to know. The person of God is curtailed according to the power of imagination and admitted just as an afterthought — who more adequately can be seen as a tribal god. And if our achievements, not God, are made the starting point, one *has* to come to such a crippled image of God. It is more appropriate, however, to repeat after G. Ludwig that "even the findings of physics are not our achievements, but a gift, and our contribution in work and effort is but trivial in comparison" (p. 106). Yet it is very painful for human pride to admit it.

Reviewed by Adam Drozdek, Duquesne University, Pittsburgh, PA 15282.

ISLAM AND SCIENCE by Parvez Hoodbhoy, London: Zed Press, 1990. 154 pages, index. Paperback.

Hoodbhoy's *Islam and Science* is a difficult book to characterize. It is divided into twelve chapters, a foreword, an appendix, and a preface by Nobel Laureate Mohammed Abdus Salam. It covers a wide selection of topics. The author's major concern, however, is the defense of modern science against all opponents, but especially fundamentalist Islam. Science, he says, is the key to a nation's power and prosperity. Once, Islam was strong, rich, and supported scientists of the caliber of Ibn Sina, while the West was poor, weak, and dominated by the Christian church. Nowadays, the situation is reversed, and if Islamic lands, such as Hoodbhoy's native Pakistan, want prosperity, they must encourage science.

Hoodbhoy sees science and religion (especially contemporary Islam) as eternal opponents. European science amounted to little during the Middle Ages because of opposition from the Church, while Muslim scientists flourished under the patronage of the Abbasid caliphs. But as the power of the *ulema* (muslim clergy) grew, and the power of the Islamic state declined, science was suppressed, as limiting God's power (pp. 1, 95). One example is al-Ghazzali's denial of causality. Fire did not cause a cotton ball to burn, according to al-Ghazzali; God made it burn, either directly or via angels (p. 105). Thanks to such attitudes in those in political power, muslim science and the Islamic world began to decline just as Europe entered the Renaissance and science escaped Christian control. Thus, it was Europe, not Islam, that had the Industrial Revolution, and was able to conquer the rest of the world, including the Islamic lands (pp. 1-5).

Perhaps the most interesting subject is the discussion of contemporary conflicts between science and Islamic fundamentalism. That Darwinism is anathema to Islamic, as to Christian, fundamentalists, is not surprising (pp. 47-48), but it is surprising to learn that many still defend the Ptolemaic model of the universe, with the Earth at the center, circled by Sun, planets, and stars. In 1982, for example, the president of Saudi Arabia's Medina University published a book defending the geocentric theory (p. 48).

After General Zia ul-Haq's 1977 coup in Pakistan, Ph.D. candidates found on their final exams questions about, say, the names of the prophet Muhammad's wives, while students who memorized the Koran got extra marks (pp. 37, 44). Zia's government also funded a conference on Scientific Miracles of Quran *(sic)* and Sunnah, where, for example, papers were presented showing that all modern science is prefigured in the Koran, or proposing to extract energy from Jinn, since everyone knows they are made from the element of fire (p. 46, also the appendix, "They Call it Islamic Science," pp. 140-154). Meanwhile, science education in Pakistan is so poor that most high school teachers understand less than American high school students (p. 39)!

For a Christian, Hoodbhoy's book is uncomfortable reading. In spite of receiving all of his higher education in the U.S., at MIT, he is ignorant of, as well as hostile towards, Christianity. His attitude probably parallels the average American's attitude towards Islam. Apparently he never met a sympathetic Christian in all his years in the West. His own religious views are not explicit, but he is clearly sympathetic to the Voltairean deists, as he says most scientists are (p. 15), and to the Mutazilites, the medieval rationalistic philosophers. His tone would seem quite natural in *The Skeptical Enquirer.*

Hoodbhoy's style is clear and workmanlike, not hard to understand. Endnotes follow each chapter, and a good

three page index ends the book. The reader who expects an historical account of scientific endeavors in the Islamic lands will be disappointed. Hoodbhoy knows little of the history of science, or of Christian Europe. For example, neither Chapter Two, The Nature of Science, or Chapter Three, Science in Medieval Europe, mention William of Occam or Occam's Razor. He relies on secondary sources for his information, such as White's *A History of the Warfare of Science with Theology* (1896; p. 27). But the person interested in Islamic fundamentalism will find the views of this opponent very enlightening.

Reviewed by Lester J. Ness, 115 Plum Street, Oxford, OH 45056-2413.

RESTRUCTURING SCIENCE EDUCATION: The Importance of Theories and Their Development, by Richard A. Duschl. Teachers College Press, Columbia University, 1990. Paperback; $15.95.

The old style of science education is the "survey approach," where the teacher requires the students to memorize a long list of facts that describe things that are found in the world: animal taxa, minerals, etc.. More recently, science education has focused on getting the student to learn to ask questions, and design investigations for him or herself, to learn science as a process of discovery. Duschl, in this book, suggests taking science education a step further.

Duschl objects to teaching science as if it were a finished product, a completed body of wisdom, for obvious reasons. He also objects to teaching science as if the changes that occur in science are of an accretionary nature: that new facts gradually accrete to the old facts, new theories grow up as slight modifications of old ones. He says that, if science is taught in this way, our science curriculum is philosophically invalid (p. 96). Instead, in the post-Kuhn age, we understand science as progressing through a series of revolutions "...in which dynamic change ... [is] the rule rather than the exception" (p. 36). If that is the way science operates, Duschl suggests, then that is also the way we should teach science. "...scientific inquiry is not as neat and clean as science educators often propose" (p. 6).

He has a good point. Science is changing so rapidly that a student is likely to have the "facts" s/he learned in high school overturned by new discoveries s/he will learn in college. If the student understands science to thrive on revolutions in which new theories overturn new ones, s/he will be ready to handle a rapid pace of change that would otherwise be upsetting. One danger Duschl alerts us to is that such students may feel that the growth of scientific thought is a "series of whimsical, irrational shifts" (p. 7) and end up believing that a scientific conclusion is "only a theory" and can be ignored. Another danger is that, if teachers ignore the processes by which scientists have arrived at our modern understanding of the world, students might dismiss the great but mistaken intellectual endeavors of the past as mere stupidity.

Moreover, Duschl elucidates, the processes by which students learn (according to psychological studies) and the processes by which scientists operate are very similar. "...both the processes of learning and the growth of knowledge in the field of science involve mechanisms in which new ideas replace old ideas" (p. 6). If science and education are similar processes, and if science has proven so successful, then shouldn't education operate the way science does?

Duschl explains that scientific theories can exist at different levels. Some are at the core, and no one doubts them, for instance the cell theory; some are at the frontier, well established but with some internal inconsistencies remaining, such as evolution; some are at the fringe, which might someday prove to be right but at the present consist of grand speculations, such as scientific creationism. This approach makes more sense than a simple black-or-white "Is it science or isn't it?" argument. This book is written by someone whose specialty is education, not science. This may account for some errors such as the author's reference to Andrew — rather than Alfred — Wallace, and William Thomas rather than Thomson (Lord Kelvin). And the reader should be prepared for a dose of educationese. However, although I have never studied education, I found the book readable. Unfortunately, it does not seem to me that the last chapter carried out its promise: it did not help me figure out how to apply the growth-of-knowledge approach to the teaching of biology.

Despite the quality of Duschl's book, I still do not believe that the American crisis in science education can be solved by implementing the approach Duschl suggests. I will have to agree with Andy Rooney. The problem is not that teachers are teaching badly (this is generally not true) but that students are not learning. Although not all science education in America is good, even that which is excellent seems to bounce right off of the students' heads, perhaps because of social problems such as drugs, perhaps because they have been raised as greenhouse couch potatoes, perhaps (as Rooney suggests) because of parents who have not taught them to think.

As evidence for this assertion, I offer the example of Japan. I sat in a Japanese high school science class in 1973. The methods employed — bordering on rote memorization — were what education researchers such as Duschl consider to be the worst possible ones. Yet somehow, despite these experiences (or is it because of them?), Japanese students lead the world in a mastery of science. Japanese education has been successful using methods practically the antithesis of what Duschl suggests. So while Duschl has done an excellent job, and while I already use some of the methods he suggests and plan to implement more, I cannot believe that "restructuring science education" will rescue science education in this country.

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THE WORD OF SCIENCE: The Religious and Social Thought of C. A. Coulson by David and Eileen Hawkin. London: Epworth Press, 1989. 127 pages. Paperback; £5.95.

Physical scientists educated in the decade following World War II became acquainted with Charles Alfred Coulson (1910-1974) through his popular works on atomic and molecular structure. Educated at Cambridge University, his interests encompassed the areas of mathematics, physics, chemistry and molecular biology. His use of quantum methods to study molecular structure led to election as a fellow of the Royal Society in 1950. He held academic posts at St. Andrews, University College, King's College and Oxford. Raised in a Methodist home in a family that valued education he became a Christian during his college years.

Coulson's most well known integrative work, *Science and Christian Belief* (1955), was foundational for an earlier generation of ASA readers. Reading the Hawkins' summary of his ideas brings home the recognition of our debt to this creative thinker. Coulson's views on issues ranging from "the god of the gaps" to "the design argument" seem commonplace today because his ideas have been so thoroughly accepted.

Coulson's interests ranged far beyond traditional metaphysical concerns to encompass the societal implications of scientific advance. Although embracing a pacifist view shortly after his conversion in 1930, he would counter those who decried the contribution of science to war with what he viewed as the great potential contribution of scientists to improving the lot of undeveloped nations. In his *Science, Technology and the Christian* (1953) he championed nuclear energy as the "great" energy source and encouraged scientists to help improve third world food production. For Coulson, science had to be buttressed by religious faith if were to serve the best interests of humanity.

Memorial University of Newfoundland Professors David (religious studies) and Elaine (mathematics) Hawkin have provided a readable study of Coulson's thought on science and faith. It would have been helpful to see how Coulson related to other scientist-Christians and the Research Scientists Christian Fellowship. The late Donald MacKay (both men were at St. Andrews University and University College) once noted that his thought closely followed Coulson. It would have been valuable to spell out this relationship as well as the sources of Coulson's thought. Other than a cryptic note indicating that his father first showed him the "unity of science and faith," we have no suggestions of links to others. The Hawkins have done an excellent piece of work with the themes that they have chosen to address. Someone still needs to write the history which links English thinkers on science and faith in the early part of the century with their counterparts in the current generation.

Reviewed by J. W. Haas, Jr., Chemistry Department, Gordon College, Wenham, MA 01984.

THE SHROUD AND THE CONTROVERSY by Kenneth E. Stevenson & Gary R. Habermas. Nashville, Tennessee: Thomas Nelson, Inc.. 1990. 246 pages l index. Hardcover.

Question: What happens when you mix an engineer with an apologetics-oriented philosopher? Answer: thoughts expressed in a book which argues for the authenticity of the Shroud of Turin based on both detailed scientific evidence and on more philosophical arguments. Stevenson and Habermas team up again to reprise their 1981 bestseller, *Verdict on the Shroud*. Many people accept the results of the carbon-14 dating performed in 1988 which indicate a medieval age. So why another book about a fake — a clever forgery? Stevenson and Habermas hope to dispel a too ready confidence in the 1988 dating tests by citing the lack of proper scientific protocol. Furthermore, they consider new evidence computer imaging and evaluate other theories of the formation of the image. Their aim is also more modest — to state conclusions in "terms of probability" since "proof is not available here. The tone of the book is forceful (although some restraint has been shown) and apologetic/evangelistic.

The book first complains of Christian-bashing which Shroud supporters receive, and then proceeds to a robust defense as it counters the skeptics' claims and arguments purporting to demonstrate the forged status of the cloth. The process of image formation is the "crux of the controversy." Either it is the result of some known natural process — either deliberate or incidental — or it is some unknown unnatural process, like the after-image of a body resurrecting through a burial cloth. This puts the burden of proof on the skeptics. They would much rather just shelve the image formation away as "still unknown but potentially knowable — without resorting to a God-hypothesis." Stevenson and Habermas do not focus on this more cautious response. Rather, they proceed to debunk the many naturalistic explanations offered so far. Furthermore, the scientific credentials of the STURP team which conducted the primary analysis and the peer-reviewed research results attest to the credibility of this debunking. One sindonologist can even "produce an image very close to that on the Shroud" on small portions of cloth with high energy ionizing radiation but would require 1000 KW(!) to produce a body size image.

The carbon-14 dating is similarly critiqued and other tests employed. Since the radiometric dating procedure was "flawed" — in at least ten ways, pollen, textile, archaeological and more types of analyses are cited to support a first century origin for both the cloth and its image. Historical, pathological and philosophical arguments are also marshalled in support of the authenticity of the Shroud. The book concludes with some personal interviews with scientists involved in Shroud research (including the skeptic Pellicori) and some answers to common questions Christians and atheists might ask.

Nevertheless, some questions remain. If a genuine Shroud "provides evidence for the validity of Christianity," would Christian apologetics and/or Christianity really have "nothing to lose" if new evidence confirms the

Shroud to be fake? Haven't sindonologists and Shroud specialists wasted a lot of time, money and arguments in a dead end street guided more by wish-fulfillment than good judgement? Why does the burden of proof fall on the atheist for the image formation process while the Christian apologist only offers a God hypothesis? Even with these nagging questions the book is informative and useful beyond its attempt to validate the authenticity of this relic.

Reviewed by Marvin Kuehn, 48 Carling St., Hamilton, Ontario L8S 1M9.

THE ROAD TO JARAMILLO: Critical Years of the Revolution in Earth Science by William Glen. Stanford, CA: Stanford University Press, 1982. 459 pages. Hardcover; $49.50.

This book discuses how the plate tectonics revolution in the earth sciences happened, the key discoveries that made it possible for the first time to seriously consider continents moving and sea floors spreading, and the scientists whose work in the 1950s and 1960s brought about this revolution. According to the dust jacket, at the time of writing *The Road to Jaramillo* Glen was a research associate in the Office for History of Science and Technology at the University of Berkeley. He is a geologist turned historian. This book is based on more than 500 hours of interviews with over 100 of the scientists who achieved this revolution in the earth sciences. The focus is primarily on how the plate tectonics revolution developed with all the conflicts, zig-zags, missed opportunities and contributions from what were at the time seemingly unrelated fields, and most especially on the scientists whose work led to this revolution.

There are three major sections to this book: 1) Building the Hourglass: Young-Rock Potassium-Argon Dating, 2) Uncovering the Key: Geomagnetic Polarity-Reversal Scales, and 3) Turning the Key: Applying the Scale. Parts I and II of this book comprise Dr. Glen's doctoral dissertation. The Table of Interviews reads like a *Who's Who* of the earth sciences in the 1950s through the 1970s. The extensive index makes finding a scientist or topic in the book quite easy. The bibliography is likewise quite thorough. The 36 figures in the book clarify some of the technical aspects (e.g, the potassium-argon dating method), track the evolution of the geomagnetic time scales, and illustrate the sea floor magnetic data. There are also numerous photographs of the scientists whose work is discussed.

The book's title comes from the Jaramillo magnetic event discovered in rocks from Jaramillo Creek in the Jemez Mountains in New Mexico. This was a short event of normal magnetic polarity of the earth's field that occurred about 0.9 million years ago sandwiched between events of reversed polarity. The Jaramillo event was the basis for the eleventh version of the time scale that Allan Cox, Richard Doell, and Brent Dalrymple constructed. And it was this version of the time scale that was used by Neil Opdyke's group at the Lamont-Doherty Geological Observatory to interpret magnetic data from the sea floor. The magnetic profiles from the sea floor rock in conjunction with the time scale that included the Jaramillo event confirmed sea floor spreading and led to the plate tectonics revolution.

Our understanding of the earth, its history, and the forces that shape the land masses even today has been profoundly affected by the ideas in plate tectonics. The upper surface or crust of the earth is a relatively thin shell of brittle rock some 30 to 70 km thick under the continent and 6 to 8 km under the ocean. This thin shell of crustal material is split into numerous plates, each of which moves as a unit and interacts with adjacent plate at its boundaries. Plate collisions can cause mountains like the Himalayas or the volcanoes of Japan or faults such as the San Andreas. And even the flora and fauna of the earth are changed when continents are broken apart or joined. All these events at the earth's surface are driven by the slow convection currents of hot rock that boil up from deep inside the earth. Thus plate tectonics links many diverse phenomena on the earth's surface and its interior.

But before the plate tectonics revolution could occur, some very important scientific techniques had to be developed, and these are documented in *The Road to Jaramillo.* Part I discusses the development of the potassium-argon dating method in the early 1950s by John Reynolds and Joseph Lipson at UC Berkeley, who built a mass spectrometer and applied it to potassium-argon age dating. In the mid-1950s, when Garniss Curtis and Jack Evernden joined them, rocks as young as 30 to 40 million years were datable, and as techniques were refined they and their students were able to determine dates as low as a few thousand years.

Part II of this book discusses the development of paleomagnetics and the study of geomagnetic reversals when the earth's magnetic field was reversed compared to what it is today. Numerous individuals worked on this problem of polarity reversal, including Allan Cox, Richard Doell, and Brent Dalrymple. These three were trained at Berkeley, worked at the U.S. Geological Survey in Menlo Park, and according to Glen "contributed the majority of the data during the pioneering stages of the polarity-reversal scale." In the early 1960s, work on determining and dating the polarity-reversal time scale progressed rapidly, a series of time scales were produced, and by 1966 the eleventh time scale with the Jaramillo event was published.

Part III discusses the Vine-Matthews-Morley hypothesis and the work done on sea floor spreading. In 1963 Fred Vine and D.H. Matthews at the University of Cambridge, and independently L.W. Morley, suggested that geomagnetic field reversals are imprinted on rock at the ocean floor to form a series of alternately magnetized stripes when the sea floor spread from the mid-ocean ridges. The stripe widths are proportional to the alternating intervals of the polarity reversal scale. Although this hypothesis was poorly received initially, in 1966 the time scale with the Jaramillo event was successfully correlated with the magnetic anomaly profiles across mid-ocean ridges, and work progressed rapidly in plate tectonics.

When I was an undergraduate at the University of Nevada at Reno in the MacKay School of Mines (1967-1972), many if not most of my professors were dubious about plate tectonics. But when I started graduate school at Stanford in September 1972, I entered an academic environment that took plate tectonics profoundly seriously. In my first year at Stanford, Allan Cox — whose work is featured prominently in this book — was my advisor, although later my research interests changed and I was assigned another advisor. While I was in graduate school, I also worked at the U.S. Geological Survey (USGS) in Menlo Park, and did my research on fault motions. Because of Allan's connections to both Stanford and the USGS, I kept hearing about him and his work, and the work of other contributors to plate tectonics such as Jack Evernden and Brent Dalrymple at the USGS. I never got to know Allan well or the other plate tectonics contributors personally, and so I was quite interested in their biographical information and the development of their professional work detailed in this book. Reading this book brought back memories of the studying I did for my Ph.D. qualifying exams. Only this time, instead of trying to master the scientific papers about what plate tectonics is and the observations and data that support such a theory, I was learning about the individual scientists and their contributions to the development of plate tectonics. So now, some 18 years after learning the scientific basis for plate tectonics, I also have learned about the people involved and how they accomplished their work.

I can recommend this book to anyone who either has a strong interest in the earth sciences and specifically in plate tectonics or who has some background in earth sciences. The book itself is not especially technical. However, the focus is on the technical details of how a scientific theory (plate tectonics) developed and on a particular method for age dating of rocks (potassium-argon). One can read this book solely for its human interest and the biographies of scientists instrumental in developing the ideas and techniques that led to the plate tectonics revolution. And on this level one can skim over the technical aspects. On another level, one can read this book for its chronicling of how a particular scientific theory came to be, in which case one must have some understanding of the technical issues. In either case, some knowledge of geology or geophysics would be useful, and specifically some acquaintance with the basic concepts of plate tectonics would be very helpful.

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NATURE LOST? Natural Science and the German Theological Traditions of the Nineteenth Century by Frederick Gregory. Cambridge: Harvard University Press, 1992. viii + 341 pages. Hardcover; $39.95.

Historical studies of the relationship between Western scientific thought and religious belief have focused primarily on the Anglo-American world, with relatively scant attention paid to the rich traditions of the European continent. University of Florida Historian of Science Frederick Gregory has begun to fill in this gap with his study of natural science and religion in 19th century German-speaking Europe. Gregory, with degrees in mathematics (Wheaton), theology (Gordon-Conwell) and history of science (Harvard) is eminently qualified to accomplish his main purpose and relate his findings to the American scene. Gregory's goals and methodology are clearly spelled out in an initial historiographic chapter. One touchstone in his analysis is the way that the participants conceived of truth through their espousal of either the correspondence (realism) or the coherence (fits a set of beliefs) theories of truth. He identifies four major schools of science-religion thought which were dominant in the post-Darwin period.

Chapter Two provides an overview of German protestant theology from the Enlightenment through the 19th century. One important school, the theological rationalists, favored the correspondence school of truth in asserting that the supernatural elements of scripture should be held up to the light of reason and discarded if found wanting. Conservative supernaturalists used reason to buttress church confessions but denied that reason could apply to such doctrines as sin, redemption and the afterlife. Between these opposing schools, the school of Schleirmacher took a different turn in reinterpreting the basic themes of Christianity along Romantic lines.

Chapter Three describes the most radical theological response to science as embodied in the thought of David Friedrich Strauss. Strauss was the first theologian to adopt a thoroughly Darwinian world-view. He invoked a purely naturalistic explanation of the cosmos based on a causal necessity which excluded God. His *The Old Faith and the New* (1872) outraged most Germans, yet attracted some adherents who felt that "he had restored unity to a world-view that had been fractured by the rapid and enlightening growth of natural science" (p. 109).

Orthodoxy's reaction to Darwin found a champion in Otto Zockler, who was the earliest and most prolific theological critic of Darwin on the continent and in the English speaking world. Raised in a conservative Lutheran home and influenced by conservative Catholic reformers, he spent much of his career defending Christianity against materialism and atheism. Gregory notes Zockler's early shift from using scientific information in apologetics as *symbolically* illustrative of the doctrines of the Christian faith to something that stood *factually* in harmony with Christian belief in general. His 1861 essay *Uber die Speziesfrage* discussed the views of Louis Agassiz and Darwin. He found both to be deficient in assuming that the natural laws of the past were the same as those of the present and chastised Darwin for espousing scientific ideas that could not be proved. He argued that the biblical interpretation of creation was a viable option for historical events. He felt that the ultimate truth would come out of the *objective* truth of science when correctly carried out. Gregory notes that Zockler took the position that American Charles Hodge would later take in ascribing the fundamental question as one involving *presuppositions*.

Zockler spent the remainder of his life dealing with the challenges of various forms of materialism, pantheism, and deism to biblical theism. He developed a "concordance" theory to correlate the Mosaic account of creation with current geology. He did not insist on six literal twenty-four-hour days in developing a system which correlated the biblical order of creation with the geological story. He estimated that humans were created about 4000 B.C. He was suspicious about geological dating, arguing that geological time could be speeded or slowed, in opposition to the prevailing uniformitarian view. In his historical writings Zockler argued against A. D. White's and John Draper's "conflict-history" of the relationship between science and religion. Zochler opposed Darwinism for its "anti-biblical implications of descent" rather than Hodge's concern with the "anti-teleological implications of natural selection." While supportive of Darwin's science, he was concerned with the threat that Darwinism held for Christianity and deplored the accommodation strategies of those who sought to relate the two perspectives. Darwin's creation story had to be false. Ironically, the conservative creationist and pantheistic naturalist shared a belief in the correspondence theory of truth.

Gregory's next figure, Rudolf Schmid, played a mediating role between the extremes of Strauss and Zockler. In holding a position which drew from both the left and right, Schmid joined them in affirming the correspondence theory of truth. One of the impressive things about these theologians was their ability to grapple with the scientific aspects of Darwinism. Each had a more than casual interest in science even though they were pursuing a religious vocation. Schmid, who had a lifelong interest in geology, started in the ministry but soon turned to education and the study of the relationship between science and religion. He held steadfastly to the doctrine of salvation and maintained a teleological world view which advocated the complete freedom of natural science. Unwilling to polarize science and religion, he was willing to revise traditional biblical interpretations or restate evolutionary theories for his purposes. He denied that one could be both a Darwinist and a Christian, but refused to isolate science and theology or reject design. Schmid's willingness to accept both "books" and the ensuing struggle that entails, reflects the position of many current evangelical scientists.

The final actor, Albrecht Ritschl, and his followers would radically abandon both realism and truth as correspondence by divorcing natural science from any link with religion — nature lost! What truths one could derive in the two areas of thought were unconnected — warfare was impossible between two camps which did not share common ground. Gregory draws on the work of Wilhelm Herrmann, whose critique of the realistic status of scientific conclusions would join him with scientists and philosophers who felt that the correspondence theory of truth was suspect in science. The extension of this notion to religious truth was inevitable. Gregory's detailing of Herrmann's thought is one of the high points of *Nature Lost*. He suggests that Herrmann had anticipated Kuhn's "incommensurability of different paradigms." His influence on young scholars such as Karl Barth and Rudolf Bultmann led to an exclusion of science and nature from the thought of two leading 20th century theologians, the effects of which are only today being addressed.

His concluding chapter, "The Future Challenge," provides a 20th century overview of the effects of the 19th century discussion. For much of the century the dominant existential school held sway for academics. Gregory argues that most scientists and lay people still sought to relate their science and faith in the context of a realist perspective and the pendulum has swung in academic circles to one of the realist positions. Karl Heim (1953), and more recently Jurgen Moltmann, Gunther Altner, Jurgen Hubner and others have led a growing effort to yoke science and religion to enhance the human condition.

Gregory has done yeoman's service in weaving the changing political scene of 19th century Germany into the science-theology story. Few historians of science are sure-footed in theology and thus avoid theological details for other cultural influences with which they are more comfortable. Evangelicals interested in more fully understanding the roots of contemporary science-religion discussions should read this work.

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HIDDEN DANGERS: Environmental Consequences of Preparing for War by Anne H. Ehrlich & John W. Birks (eds.). San Francisco, CA: Sierra Club Books, 1990. 246 pages. Paperback.

Can America afford the environmental and economic costs of our military industrial complex? Ehrlich and Birks and thirteen other scholars think not. And in our post-Soviet Union world the futility of building a society and an economy around military products seems more plain than ever. This book is divided into two parts: the realm of nuclear weapons production and research, and a collection of papers on consequences of non-nuclear military production.

The nuclear section contains eight papers dealing with nuclear reactors, wastes, transportation, unsafe plants and technologies, weapons testing, nuclear winter and the conflict between production vs. safety and cleanup. The authors carefully detail a well-documented history of the U.S. nuclear weapons program. The authors paint a consistent picture of deliberate government misinformation, mismanagement, unsafe and expensive projects, all of which damage both the health of the populace and the economy.

Secrecy and expediency were paramount in the World War II days which precipitated the rush into nuclear weapons. Then the Cold War from Stalin to Reagan allowed the cloak of secrecy and the appeal to national security

to maintain the headlong rush to more, bigger and more potent weapons. Small accidents and dissenting critics were dismissed until Three Mile Island and Chernobyl. Since then, the safety and economics of building, running and finally decommissioning nuclear reactors and weapons production facilities has become an alarming concern to informed observers. The authors do note that public pressure is proving effective in making the DOE and the military-industrial complex more accountable.

The chapters on nuclear weapons testing and nuclear winter are particularly effective. They clearly lay out the consequences of past tests and the possible results of nuclear conflagrations in the future. While previous chapters occasionally overwhelmed this reader due to the long lists of large numbers (35 million curies, $85 billion, 35,000 tons of mercury), the human faces and anecdotes provided a readily accessible yet still overwhelmingly horrific account of what nuclear bombs actually do.

The second part of the book opens with the chilling prospect of even greater problems associated with biological and chemical weapons. The development, testing, stockpiling and eventual disposal of this class of weapons exhibits the same features found in the nuclear weapons program: danger to human health, adverse effects on the economy, cost of cleanup...

The book closes with essays by psychologists and economists showing the deleterious effects of militarizing a country.

The General Accounting Office estimates the cost of cleanup and maintenance to the Department of Energy's nuclear weapons complex at $175 billion (the annual nuclear weapons budget is $8 billion). The two contributing economists trace the link between military spending and an ailing economy quite ably by analyzing the economic histories of the U.S.A. and the (former) U.S.S.R. in comparison with post World War II Japan and Germany. Yet a cautious note of hope is sounded. The peril of nuclear war may strengthen the desire to resolve conflicts through diplomacy and "challenge...our species to grow out of its adolescence into full adulthood." Secondly, an economic reconversion from military back to productive civilian technologies would strengthen the economy of America, reverse the arms race, and keep more of the citizenry gainfully employed.

Hidden Dangers does indeed expose the problems America faces from its socio-economic militarization. The authors present a scathing review of the history and present-day state of the military-industrial complex. Is it one-sided? Yes, but the other side will have great difficulty making a case for continued military development in our society. Issues that were once poorly understood, or deliberately ignored, now are becoming increasingly important to a voting public: safety, the necessity of more weapons, the utility of our present arsenal, the cost of production, the costs of maintenance and cleanup, the likelihood of enemy attack and also the psychological effect on society. These concerns must become part of the algorithm used to set Pentagon policy.

Reviewed by Marvin Marcinko Kuehn, 106-3731 W. 6th Avenue, Vancouver, BC.

ON METHUSELAH'S TRAIL: Living Fossils and the Great Extinctions by Peter Douglas Ward. W.H. Freeman & Co., 1992. 212 pages. Hardcover.

Ward is Professor of Geological Sciences and Curator of Invertebrates at the Thomas Burke Museum at the University of Washington in Seattle. A paleontologist, he has published extensively on the nautilus and its fossil relatives, the ammonites. The present book, as its title implies, deals primarily with those organisms who have survived the great extinctions of the past 500 million years. Although the author considers most extensively those invertebrate organisms with which he is most familiar, such as brachiopods (clams, etc.), gastropods (snails, etc.), and cephalopods (nautilus and ammonites, relatives of modern day squid and octopi); he also has chapters on the horseshoe crab and the coelocanth, and considers briefly the extinction of dinosaurs. He discusses the types of plants that were prevalent in the various periods, and the role they play in the survival and disappearance of animals.

Dr. Ward is an entertaining writer and he intersperses descriptions of field trips with his discussions of paleontology. The book is not written in highly technical language, and where the latter is used, adequate definition of terms are generally given. The book does not have an extensive listing of references and many of those listed refer to books. This aspect might prove to be a limitation for the use of the book by those who are more technically minded. The field trips described by Ward take the reader from the examination of Cretaceous boundary fossils along the coast of Spain, to the cold deep waters of Puget Sound, to the coral ridges of the south seas, as well as to many areas of the United States. Although the findings of these trips are seldom dramatic, the reader is given a feel for the rigors and the varied types of field study carried out by paleontologists.

Philosophically, the author generally subscribes to the punctuated equilibrium explanation of evolution proposed by Niles Eldridge and Stephen J. Gould, although he does deal extensively with Darwin's ideas on gradualism. He notes that Darwin felt that if gradual change could not be demonstrated in the fossil record, his ideas on natural selection would be totally inadequate. The lack of Precambrian fossils followed by the sudden appearance of many phyla in the Cambrian period (about 590 million years ago), has always posed a problem. Ward discusses this in considerable detail, and describes more recent evidences of multicellular life without skeletons in the Ediacarian fauna (late Precambrian). He considers the limited number of Precambrian fossils and the variety of Cam-

brian fossils to be more satisfactorily explained by the punctuated equilibrium hypothesis. Ward is a paleontologist and not a molecular biologist. Consequently, he considers the fossil record from the standpoint of sequential change, using words like "evolve," "evolution," etc., in that sense, implying ancestral relationships for those with similar structures. He considers the role of natural selection in the establishment of new organisms to be very important once the organisms are formed. Only once did I note the term "mutation" as an explanation for the development of new characteristics. He presents a fascinating discussion of the types and significance of new morphological structures in various animal species; also the role of these structures in the survival of new species and in the disappearance of older species. He discusses such features as shells, including development of air pockets within these shells; modes of locomotion; and ability to survive in deep water, or in waters of various salinities. It should be noted that there is much speculation involved in discussing matters such as these, yet I felt he was attempting to be fair in presenting his ideas. He often presented alternative explanations when he deemed it appropriate.

As noted in the title, a major theme of the book is the paleontological evidence for the major mass extinctions. He noted that the most extensive of these, the Permian extinction of about 250 million years ago, does not appear to have any extraterrestrial explanation (e.g., a meteor impact) and suggests that it may have been a consequence of climatic changes due to the continents coming together as a single land mass (Pangea). Other extinctions (213 million and 66 million years ago) are considered by Ward to have been a more likely consequence of collisions with meteors or other extraterrestrial bodies. In each case, however, Ward considers the possible climatic changes (temperature, rainfall, sea level changes, glaciation, etc.) to have ultimately played a greater role than the immediate consequences of the impact. He comments extensively on the effect of mass extinctions, not only on the number of species, but also on the number of families and genera. He then notes the rapid diversification of surviving organisms following the extinctions, to fill the vacant ecological niches. He does, however, note that some organisms (e.g., the nautilus and coelocanth) survive, but do not diversify, and considers possible explanations for these latter findings. An interesting question posed by the author is why the ammonites, who survived all previous extinctions, disappeared at the end of the Cretaceous period (66 million years ago), yet the related organism, the nautilus, has survived to the present day. In considering the disappearance of various organisms, Ward pays particular attention to the role of predators, both on land and in the seas.

In considering vertebrates who might be classed as living fossils, Ward goes into considerable detail regarding the coelocanth. This lobed fish has not been noted in the fossil record in the last 100 million years, although Ward found evidence of coelocanth scales in strata about 80 million years old. He describes in detail the saga of the discovery of living coelocanths near the Comoros Islands in the Indian Ocean 40 to 50 years ago. The coelocanth had long been considered, based on studies of fossil bones, to be a possible intermediate between fish and reptiles. Yet Ward notes that modern studies on the internal organs of the coelocanth do not fit that interpretation. He emphasizes the dangers of building too much interpretation on structural features preserved in fossils (bones, primarily), when little is known of other functional organs of the body.

If one keeps in mind some reservations regarding philosophical interpretations noted earlier, this reviewer would recommend this book highly for ASA readers. As the authors note, invertebrate organisms do not have the dramatic popular appeal of dinosaurs and large mammals, but they do have a very important story to tell.

Reviewed by Gordon C. Mills, Department of Human Biological Chemistry and Genetics, University of Texas Medical Branch, Galveston, Texas 77550.

ANIMAL LIBERATION by Peter Singer. New York: New York Review of Books, 1990, 2nd edition. 320 pages. Hardcover.

The first (1975) edition of *Animal Liberation* has been an extremely popular and influential book, and it has provided a tremendous impetus to the animal liberation movement. The title of the book was derived by analogy to other liberation movements of the 1960s and 1970s, black liberation, women's liberation, etc. The second edition updates the first by including some of the major developments which have occurred in the animal liberation movement since 1975, by updating many of the examples of animal use and abuse, and by considering some of the many publications which have appeared since 1975.

The gist of Singer's philosophical position is that our current attitude towards animals is "speciesist." That is, according to Singer we are guilty of "speciesism" which he defines as "a pre-judice or attitude of bias in favor of the interests of members of one's own species and against those of members of other species" (p. 6). Singer develops his argument against animal use by drawing parallels to racism and sexism. "I ask you to recognize that your attitudes to members of other species are a form of prejudice no less objectionable than prejudice about a person's race or sex" (p. v). An underlying assumption of his argument is that humans are animals like all others (or at least like all others capable of suffering), and that there are no grounds for considering humans distinct and in a different ethical category from other animals. He considers that the capacity to suffer and/or experience enjoyment is the only defensible boundary of concern for the interests of others (p. 8). And since this capacity is shared by animals, the interests of animals must be considered equally with the interests of humans.

About half of the book is devoted to chronicling the abuse of animals by humans in research and in factory farming. Many of the examples of animal use in research,

given by Singer, are atypical and appear to be selected because of the apparent abuse of animals that occurred. While describing the experimental techniques involved, Singer rarely supplies the rationale or context for doing the experiment, so that the impression one is left with is that animals were being made to suffer for no useful purpose. While Singer does tend to identify worst case scenarios, many of these abuses are real. However, it is entirely reasonable to want animals better treated than they are and to want abuses corrected wherever they exist, without promoting the abolition of all use of animals or without adopting Singer's philosophical assumptions.

It is the claim that the interests of humans and animals are equivalent that most Christians will find objectionable in Singer's philosophy. Singer clearly recognizes that his position is incompatible with the Christian perception of humans as being made in the image of God and set apart from the animals. Singer appears to interpret the scientific theory of evolution as supporting an atheistic origin of the universe (pp. 205-207). This assumption then underlies his conclusion that humans and other animals are morally equivalent.

I found this book well written and easy to read. The author presents his ideas unambiguously and, although one may disagree with him, he presents the case for "animal liberation" with clarity and skill. It is particularly important that those who use animals either for food or for research be knowledgeable about the sort of opposition that is developing in the animal rights and animal welfare movements. The goal of these movements is the abolition of animal use by humans both in research and as food, not simply the elimination of unnecessary cruelty. Animal users, including not just researchers but all non-vegetarians, need to be prepared to present a well articulated justification for their use of animals. This book is better written than a good deal of the literature emanating from the animal rights movement (much of which is based on emotional appeal) and clearly articulates some of the underlying philosophy on which the animal liberation movement is based. I would recommend it as required reading for anyone interested in the current animal liberation debate or in the use of animals by humans.

Reviewed by Steven R. Scadding, Department of Zoology, University of Guelph, Guelph, Ontario, Canada, N1G 2W1.

HOPE FOR THE LAND: Nature in the Bible by Richard Cartwright, Austin, Atlanta. John Knox Press, 1988. Paperback.

Hope for the Land is the third book in the series *Environmental Theology*. In the first book, *Baptized into the Wilderness: A Christian Perspective on John Muir*, Austin develops a framework for a Christian appreciation of the natural world, and illustrates this framework from the writings of John Muir. The second book, *Beauty of the Lord: Awakening the Senses*, develops a framework for awareness of God's communication to us by an appreciation of the natural world, illustrated by the writings of Jonathan Edwards. A fourth book is projected, in which application of these principles is made to both personal ethics and environmental issues. The author has given much effort to these subjects both as a Presbyterian minister focusing on environmental theology and its associated political issues and also as an organic farmer.

This book is subtitled *Nature in the Bible* and true to its title, its most noticeable characteristic is the wealth of extensive Biblical quotations. Until one actually goes through the Bible and collects the quotations that make mention of soil, plants, and animals, as Austin has done, one does not suspect what great attention the Bible devotes to the natural world. Many other books and articles about the relationship between the Bible and ecology cite just a few verses. This is particularly true of the writings of Lynn White and of Roderick Nash, in which reference is made to little except Genesis 1:26. Even H. Paul Santmire's *The Travail of Nature* (reviewed in *Journal ASA* 39:54-55), and George S. Hendry's *Theology of Nature*, good as they are, use scanty Bible references by comparison to Austin's. *Luchar por la Tierra*, published in Ecuador by an obscure Jesuit priest, is the only other book I have seen so extensively reviewing what the Bible says about the relationship between land and people.

Austin expands the concept of ecology to embrace a "moral ecology": "The purpose of the covenant, which embraced holy people and holy land, was to recreate the moral ecology, so that god, humanity and nature might again have just and fruitful relationships" (p. 155). The theme that our relationships with God, with each other, and with the land form one continuous fabric pervades the book.

In the manner of Wendell Berry, Austin makes the point that our relationship with the natural world cannot be separated from our relationship with one another; in particular the relationships between men and women reflect and influence our treatment of the land. For instance, the commands regarding the "sabbath of the fields" were at once intended to give rest to the land, to provide gleanings for the poor, and as worship to God. He also points out that violation of the responsibility to let the land rest was serious enough of a sin to be cited (II Chronicles 36: 20-21) as a reason for exile of the Israelites. Even more, Austin refers to scriptures that say that the earth itself is one of the parties of the covenant between God and Israel; the land itself has covenantal rights. He supports this with such quotes as Deuteronomy 22:6-7 and especially Hosea 2:18 ("I...will make a covenant with the beasts of the field..."). As a result, modern mans' (including Christians') love affair with materialism constitutes "technological idolatry" (p. 197).

My only substantive criticism is that the author does not seem convinced that the Bible is really a reliable communication from God, and seems only weakly convinced that the "tales" in Genesis, Exodus and Joshua even held meaning for the Israelites in general (p. 150). I believe he

could have found even richer insights in Scripture than he did if he was convinced that its writers were completely guided by God. And in a couple of places I think he went too far: "The goal is for all species, through Christ, to recognize each other as God's children" (p. 207) and "Apart from the earth there is no salvation" (p. 208).

A recurring problem for Christian environmentalists is to fit environmental preservation in with Christian eschatology. The Bible presents differing visions of the ultimate future: some parts suggest a fiery destruction of the earth, while others (such as Isaiah 41: 17-20 and Ezekiel 47: 1-12) depict an ecologically healthy earth. Understandably, Austin has not resolved this difficulty, and has simply chosen to go with the latter vision:

> Christ did not come to rescue a handful of believers from this world. He came to renew creation, to restore humanity and nature to full communion with God, and to bring all creatures into just and compassionate relationships with each other through the inspiration of his own humble sacrifice" (p. 206), ... [and] ... biblical visions give me hope that the redeemed community will be realized on this earth among the species and the cultures familiar to us (p. 215).

I was deeply moved by reading this book and felt renewed in my participation in Christ's mission of healing the broken relationships among humans, God, and creation.

Reviewed by Stanley Rice, Department of Biology, Huntington College, Huntington, IN 46750.

SACRED PLACES: How the Living Earth Seeks Our Friendship by James A. Swan. Santa Fe, NM: Bear & Company Publishing, 1990. 237 pages, index. Paperback; $12.95.

Sacred Places is written to a New Age audience familiar with geomancy, magnetotropism, crystals, and gaia. If it were a magazine article, I would recommend it for Swan's meticulous reverence for the earth, and his insightful suggestions at the end about environmental education.

Swan, a psychotherapist, environmental activist, and student of sacred places for over 16 years, shows great respect for Indian and Eastern culture. The spiritual places include burial grounds, purification spots (such as the mineral baths in Big Sur, California), healing places (Hippocrates himself believed that place had an influence on health), temples, dreaming places, and ancient astronomical observatories. Christianity, however, doesn't fare as well.

He cites an old Virginia law concerning discovery of human remains: "If they are judged to be Christian, they are immediately returned to the local church for reburial. If they are Indian, they are sent via U.P.S. to the Smithsonian for study and storage" (p. 6). Surely Christians have done something better than forget to repeal one archaic law. We have a heritage of sacred places too, from the blocked gates of Eden to Beth-El, where Jacob dreamed of angels, to the Promised Land and the Holy City.

One place Christians do show up in a positive light is where Swan reprints a formal letter of apology from an ecumenical array of Christian leaders in the Northwest to Indian and Eskimo spiritual leaders. They ask pardon for the churches' "long-standing participation in the destruction of traditional Native American spiritual practices" (p. 163). "It's about time," Swan seems to say.

Swan argues convincingly that we have separated God, nature, and science, and that it's time to reunite the three. Our schools have ignored the divine, he laments, and he calls on scientists, judges, athletes, architects, doctors, and others to rediscover nature and God (the two seem interchangeable to him) both personally and professionally.

Very quickly, the middle of the book becomes a rather sterile list of evidence for the sacredness of certain places and the danger they face from rangers and entrepreneurs. But the end is as brilliant as the middle is tedious. Swan gives an invaluable list of techniques for environmental education, which goes well beyond showing pictures of polluted rivers and dead seals. Among them are growing some of your own food to recover the "sense of awe which comes from seeing our food grow, gathering it, killing it, and cooking it" (p. 197); having "energy fasts"—cutting off all electricity to see that life still exists without televisions and digital clocks; learning to gather simple ecological data; and going to the woods to develop "the ability to feel at ease in nature" (p. 197).

Sacred Places may spark a desire in the sympathetic reader to return to Carl Jung and William James, or to climb Mount Katahdin (one of the listed sacred places), if not to read more of the author's books.

Reviewed by James G. Bishop, English Instructor, United States Air Force Academy, Colorado Springs, CO 80840.

STANDING GROUND: A Personal Story of Faith and Environmentalism by John Leax. Grand Rapids, MI: Zondervan Publishing House, 1991. 127 pages. Paperback; $7.99.

New York State needed a site for a nuclear waste dump. Commissioners chose locations near the author's home town in Allegany County, an undeveloped and sparsely populated area. Poet and Houghton College professor John Leax began to see the dump site as a moral issue—one that shows the nuclear industry's irresponsibility hiding

behind the lie of cheap power. Leax joined a protest group, the Allegany County Non-Violent Action Group (ACNAG), and after small skirmishes, court injunctions, threats of $1000 fines and imprisonment, a showdown occurred. On April 5th, 1990, protestors blocked a bridge with chains, farm equipment, and about a hundred people. A phalanx of state troopers began to make arrests, eventually hitting people and even horses with their nightsticks. Midway to the site, the troopers retreated. That is the narrative of Leax's short journal.

But that story is not the joy or even the essence of *Standing Ground*. In fact, the showdown between the New York State Police and ACNAG is too short to be climactic.

Leax has a vision deeper than split atoms and cheap power. He writes, "The dump is an issue. It is not the issue. The issue, even here, is love" (p. 57). Leax writes thoughtfully about being a Christian, saving a beautiful spot on the earth, and even hating (yes, hating) commissioners and their industrial kin. Debunking the stock notion of hating the sin but loving the sinner, Leax writes, "At what point does a sinner become his sin? At what point does the distinction cease to matter?" (p. 43).

This book is not a call to action. It is not a diatribe on the evils of the nuclear power industry. It is a meditation in the midst of turmoil. Leax wrote this daily journal in his makeshift cabin beneath a hemlock tree, as protests against a proposed nuclear dump (and arrests) escalated. The result is a mixture of calm insight and calculated rage. For example, at one point, Leax draws a tough conclusion about love and tolerance:

> "Too often I confuse holy with nice, and I choose niceness. I lack the rage of a prophet, of an Amos or a Hosea. We in the Church of the Sanitized Word have become like the patrons of art who consider a Van Gogh on the wall status but a Van Gogh in the family hell." (p. 34)

There is a bold and even blunt honesty in *Standing Ground*—not merely the confessional honesty of admitting he'd rather hide than be arrested or of calling their nonviolent protest, in reality, "semi-violent." Remarkably, his honesty includes the positive. He shows the beauty of the hemlocks, the rain, the bluebirds, and even the silence on his four and one-half acres. His honesty includes quoting Will Campbell's eight-word definition of Christianity: "We're all bastards but God loves us anyway" (p. 72). His honesty includes five beautiful, celebratory psalms that close the book. And finally, after the dust of the struggle with the policemen settled, his honesty includes saying, "I cannot comprehend...what it all means" (p. 16). Like his other journal, *In Season and Out*, this book is like a walk. It stops and savors unexpected things. It has a destination, but the joy and the insight more often result from what jumps onto the trail.

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CARING FOR CREATION by Anne Rowthorn. Wilton, CT: Morehouse Publishing, 1989. 14 pages, notes, index. Paperback; $11.95.

THE MEANING OF LIFE IN THE 1990'S: An Ecological, Christian Perspective by Michael Dowd. Woodsfield, OH: Living Earth Christian Fellowship, 1990. 58 pages, bibliography. Paperback; $5.00.

The purpose of these two books is to present a new Christian perspective on ecology and environmental concerns, to counteract what has been usually only a slight involvement of Christians in these issues. This is a critical area of concern for Christians and one that needs to be much more extensively considered and discussed. At least since Lynn White, Jr., proposed the thesis in his 1967 paper, "The Historical Roots of our Ecologic Crisis," that indifference to and degradation of the environment could be traced directly to the Judeo-Christian view of the superiority of mankind over nature, thereby granting human beings the right to exploit nature as they pleased, Christians have been sensitive to this charge and sought to refute it. Already in 1970 Francis Schaeffer responded in *Pollution and the Death of Man: The Christian View of Ecology*, arguing that the Christian response to the abuse of the creation mandate was not to move to the other extreme of redivinizing and resacralizing nature, but rather both to affirm the oneness of human beings at the level of creaturehood with the rest of creation, and at the same time to emphasize the role of human beings as special creations of God to be God's stewards of the rest of creation for Him.

These two books are written by Christians with a deep concern for the integrity of the earth and its environmental care. Anne Rowthorn has previously authored two other books and is a member of Witness for Disarmament. Michael Dowd is pastor of a congregation in the United Church of Christ; he and his wife are directors of the Living Earth Christian Fellowship, an organization committed to learning, living, and sharing the new cosmology with others. Both books testify in a dramatic way to the intense concern of the authors for environmental issues and their desire to have Christians play an appropriate role in dealing with them. Both books, however, run considerable risk of obscuring the biblical perspective.

Rowthorn finds our current dilemma to be the result of a failure on the part of Christians "to affirm the world as God's own Creation, to affirm it generously and wholeheartedly," on "Christians' lack of appreciation for the connectedness of all of life, both natural and animal, as well as our lack of recognition of our dependence upon the natural world," and on Christians' "dualistic approach to the world that says some of life is sacred, the rest secular." These are at least partially justified critiques and ones to which Christians need to pay far more attention. The case becomes a little overstated when Rowthorn goes on to say that "the well-being of the world and all its people is, or ought to be, the church's first consideration."

Rowthorn's chapter titled "The Rape of Creation" is sobering reading indeed, as she points out the large num-

ber of ways in which human civilization has and is acting to destroy the created world and its creatures. The tragic misuse of resources must be confessed when "the same amount now being spent *every two weeks* by the nations of the world on armaments would be enough to provide adequate food, water, education, health care, and housing for every person on earth for a year." She argues that in the Bible "there is nothing to suggest that human beings are to dominate other people or that in ruling the natural world they are to rule *the forces of nature.*"

Rowthorn appeals for a vitalization of the laity (one of her other books is *The Liberation of the Laity*) to avoid the "deadly duel between clergy and laity" that characterizes too many churches. When faced with difficult issues like environmental concerns, "both sides hold back to avoid division within the community." In another place she writes, "Since the end of World War II, our churches have been dominated by the CPE therapeutic model (Clinical Pastoral Education). Pastors became therapists; churches became places where parishioners — particularly women — took their 'problems.' "

The chapter titled "Causes and Consequences" starts with a number of poignant illustrations of how badly alienated we are as sinful human beings from God's calling for us to live consistently for Him. The path becomes a little less clear when Rowthorn makes a strong call for the "resacralization" of nature. If by this she means that we need to see nature as a creation of God and thereby invested with intrinsic value, well and good; but if she means that we really need to resacralize nature so that we perceive natural objects as being identified with God Himself, we have moved down the path toward pantheism in our effort to preserve environmental concern. Again when Rowthorn says that "sin and blessing are — in every way — two sides of the same coin," it begins to sound uncomfortably like "yin and yang."

Distinctives are also blurred in the chapter on "Listening to the Land; The Witness of Native Cultures." Native cultures may indeed have been more sensitive to their relationship to the environment than we have been, but it does not follow that the details of their models for expressing this relationship should be accepted by Christians. One might wonder what is meant when Rowthorn writes, "everyone needs to remember that Christ came for the sake of the world — not the church — and Christ lived and died for the well-being of the world and of every person and aspect of Creation." Or how one should interpret her final question, "Can we evolve spiritually and emotionally in time to control the overwhelming evil that our advanced and rational intellect has created?" Is the evil the result of our rationality or our innate sinfulness? Is our salvation in our ability to evolve spiritually and emotionally, or in yielding our lives as servants to Jesus Christ?

Dowd's program is much the same as Rowthorn's, for he also "sees the divine in everything that lives." But he has fastened on what he considers a "new cosmology" arising from the findings of modern science that enables us to save the material world by declaring it to really be spiritual. Although Dowd's goal is certainly one with which Christians will agree, and his deep felt sense of concern for the environment and the earth is something with which Christians can readily identify, his method is particularly unfortunate since the claims for the "new cosmology" are not rooted in reality. Modern science simply does not provide the insights or results that Dowd refers to.

Some of the fundamental errors in the "new cosmology," referred to by Dowd, may be summarized as follows. It is not true that "scientists have come to see that all matter has a mysterious, psychic/spiritual dimension." It is not true that "physicists are beginning to tell us that every atom of the universe has an inner intelligence which is non-material and ultimately unknowable." It is not true that "the earth is alive and we are the Earth's reflexive consciousness." It is not true that "there is nothing in existence that does not have subjective experience." It is not true that "every being, from individual atoms, to individual persons, to individual solar systems, to individual galaxies, has a non-material center, an inner intelligence." It is undeniable that several people have made such claims, and have argued that these claims are based on modern science; it is essential to recognize, however, that such claims arise not at all from science but totally from the personal faith convictions of those who speak in this way.

It is equally unsettling when Dowd reveals what the impact of these falsely assumed recognitions are for Christian theology. He considers one person who preaches "the need to repent, believe in the Lord Jesus Christ, and surrender our lives to the will of God in order to enter the Kingdom of Heaven" as saying much the same thing as a person who proclaims "the need to humbly change our thinking and live according to the laws of nature so that evolution can continue with awareness." There is no point in being committed to "personal salvation unless one is equally committed to planetary salvation." Sometimes the position sounds disturbingly like a kind of monism: "Sin is the fruit, not the root of the problem. The root of the problem is alienation from our larger Self." Personal salvation becomes "the process of reconciling with God, other people, and nature — to one's larger Self — and participating in the reign of love and truth." "To 'evangelize the world' or 'preach the gospel' in the coming millennium will mean educating people in the new cosmology from a Christian perspective."

Theologically, it is not true that "this cosmology can be understood as an integral part of what the church has traditionally anticipated as 'the second coming of Christ.' " It is not true that "ignorance, not evil, seems to be the root of the problem." It is not true that the commandments of God are found "through empirical observation of the universe."

Although he affirms that "the Bible has been, is now, and always will be our inspired and authoritative spiritual guide," he follows almost immediately with "Nature is the primary Bible." His position leads him to believe that differences in religious development are the consequence of the will of God, and that efforts to remove these dif-

ferences (to evangelize all people into Christians) would be contrary to God's will. "The primary scripture of the universe clearly indicates that God's will never was, is not now, and never will be that all people become Christians." What is at least one significance of the incarnation of Jesus? "Through the differentiated subjectivity of Jesus, the universe experienced in consciousness the fact that it was an incarnation of God."

Finally Dowd summarizes by saying, "We are neither stewards, nor caretakers, nor anything else that assumes we are separate from nature. We have no existence apart from the living Earth. We *are* the Earth." Most unfortunate is the continued assertion, "Recent discoveries in the natural sciences have led to a new understanding of reality." Whatever truth there is in this statement, it cannot be applied in the way that Dowd and others are attempting.

Christians who want to have their thinking about Christian perspectives on the environment stimulated and broadened can certainly use these two books to exercise their considerations. But we must not let the idea take root in the Christian community that these aberrations on Christianity are the prescribed way to go.

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

GLOBAL DUST BOWL: Can We Stop the Destruction of the Land Before It's Too Late? by C. Dean Freudenberger. Minneapolis: Augsburg, 1990.

Earth's environmental problems, in particular the erosion and decertification of arable land, are complex interactions of the natural and social sciences, of economics, of philosophy and religion. These problems require the attention and diligent work of many experts in narrow fields, for instance toxicology and agriculture, but also require leadership from cross-disciplinary individuals who are able to integrate these many different fields of study. One such individual is the author of this book. Freudenberger has an extensive background in international agriculture, but is professor of Christian ethics at the Claremont School of Theology. He worked as an agricultural consultant in more than thirty countries for thirty-five years during a time when agriculture in many "developing countries" was beginning the long and incomplete transition away from colonial export agriculture and toward becoming self-sustaining in food production. He describes his experiences as an agriculture student in California and as an agricultural consultant in Sarawak and what is now Zaire. We who teach or are concerned about issues either of the destruction of our common environment, or of feeding the hungry, need to listen to Freudenberger's voice of experience.

This book does not attempt to be comprehensive. It is a slim volume of personal reflections, but also contains many interesting and vitally important facts. Furthermore, the author exhibits clear thinking about big issues; for instance, he explains that neither capitalism nor socialism is the answer to our dilemma (p. 21), thus breaking free from the dichotomous thinking that enslaves so much modern writing on global subjects. Further, he points out that strong agriculture is as important for "national security" as is a strong military defense. He also describes the similarity between the predicament of third-world agriculture and of U.S. agriculture: both have been colonialized, the first by the interests of the industrial countries, the second by the interests of the industrial cities. This is a disturbing insight to those of us who think that colonialism is something that happens somewhere else.

Most of us can agree with the author's conclusions; and we can accept the definition, guidelines, goals, strategy, values, and motivation of agricultural ethics that the author presents (pp. 105-106). The author's viewpoint is consistent with Christian ethics but he could have made a much more biblically-centered case while reaching the same conclusions. When he said "Humanity is not the measure of all things," (p. 32), this would have been the perfect place to declare that humans have a responsibility to love the creation because it is an expression of the Creator, but instead he says, "Perhaps the health of the earth is the measure." He seems to suggest that right and wrong are defined by their effects on the environment (as Aldo Leopold said, "A thing is right when it contributes to the ... harmony of the biotic community. It is wrong when it goes the other way") rather than by their consistency with God's will. So while many of us can agree with practically all of Freudenberger's conclusions, and share his powerful concern, we may follow a different line of reasoning to reach those conclusions.

One point in particular has inspired me in reading this book: Freudenberger says that the concepts of preservation of natural resources, and of land stewardship, are not good enough; we should not merely conserve the land, but should enrich it, leaving it *better* than we found it. This, plus pieces of *good* news (for instance, the success of the French government in restoring the family farm, and the recent increase in funding for research into ecological agriculture), serve as a challenge and an encouragement to those of us who sometimes wonder if our teaching, writing, and labor can have any effect.

Reviewed by Stanley Rice, Department of Biology, Huntington College, Huntington, IN 46750.

THE BRIGHTER SIDE OF HUMAN NATURE: Altruism and Empathy in Everyday Life by Alfie Kohn. New York, Basic Books, 1990. 400 pages. Hardcover; $19.95.

Kohn illustrates the truism that in order to write clearly you must think clearly. This book is a product of extensive research, careful reasoning, and lucid writing. Kohn is an independent scholar, lecturer, and journalist. He has

written for many magazines and his 1968 book, *No Contest: The Case Against Competition*, won the National Psychology Award for Excellence in the Media. Other reviewers have assessed this book as an "important book," a "major contribution," and "a masterpiece."

Kohn's writing is informative, impassioned, and frequently persuasive. His scholarship is revealed in his handling of information from a variety of disciplines. He thinks the contributions of sociobiology are obvious and ridiculous and that "there is no point in listening to what sociobiology has to say" (p. 213). Psychology and economics are faulted for sharing the erroneous belief that "humans are actually out for themselves even when they go out of their way for others" (p. 194). In the process of eviscerating egoism (the belief that people always act in ways that benefit themselves), Kohn criticizes the views of such notables as Sigmund Freud, David McClelland, Richard Dawkins, and Ayn Rand.

The major thesis of this volume is that human beings by nature are as likely to help as to harm other people. The author thinks that an accurate paradigm must include both the dark side (aggression) and the bright side (altruism) of human nature. Kohn contests the popular belief that aggression is innate, that altruism springs from selfishness, and that moral behavior must be imposed by society.

Kohn thinks the view that it is human nature to look out for "number one" to the neglect of others is erroneous. It overlooks the strong evidence that humans are altruistic, viz., show concern for others without consideration of personal benefit. Generosity, empathy, and altruism, argues Kohn, cannot be reduced to mere self-interest. Kohn's position is bolstered by 38 pages of references containing hundreds of studies from a variety of academic fields including psychology, sociology, biology and economics.

Kohn discusses the two perspectives on altruism. The first springs from the philosophical viewpoint known as egoism which states that individuals always act to advance their own interests. This is the popular view in our culture and is the view favored by biology, economics and psychology. The second perspective disagrees with the belief that every human action is motivated by self-interest and uses as its primary example altruistic acts. States Kohn, "altruism stands on ground at least as firm as that beneath the egoist."

Perhaps altruism does exist, but Kohn concedes the fact that staunch egoists will not be convinced. Most egoists will probably agree with Kohn's pronouncement that "there is reason to doubt whether the existence of genuine altruism can ever be empirically demonstrated — at least to the satisfaction of skeptics" (p. 205). Research conducted in this area has not settled the matter because the results are inevitably ambiguous and can be made to support either position.

One example will illustrate the difficulty in supporting the view that altruism is untainted by self-interest. Kohn reports a study which indicates that those who are preoccupied with getting as much out of marriage as they give were less satisfied with their marriages when compared with those who were not so exchange oriented. While this study supposedly supports the view that lopsided relationships show that helping behaviors frequently go unrewarded, it may actually illustrate the opposite. It could be maintained that the more satisfying marriages which result from such relationships are the payoff. This would then support the egoists contention that self-interest with potential self-benefit is at the root of all so-called altruistic acts.

Kohn includes some embarrassing comments about religious people. For example, "the presence or absence of religious belief, meanwhile, tells us absolutely nothing about the likelihood of someone's engaging in prosocial activity" (p. 80). A long parade of findings demonstrates that "churchgoers are more intolerant of ethnic minorities than nonattenders" (p. 79). A study which compared born-again Christians, conventionally religious, nonreligious, and atheists found that the only group in which a majority did not cheat was composed of atheists (p. 80).

The book contains too few footnotes and too many endnotes. The difficulty in locating the endnotes provides enough aggravation to succumb to the urge to pass them by. This is unfortunate because they frequently contain useful cautions and explanatory material. Also, there are a good many redundancies in the presentation. The distilled essence of the book is found in chapter 8 entitled "Altruism Regained." Everything leading up to that is relevant as background, but not essential to understanding the crux of the debate. The index is annoyingly incomplete. For example, "economics" never occurs in the index, although the discipline is referred to several times.

Finally, Kohn contends that the pleasure which may result from altruistic acts does not necessarily provide the motivation behind such acts. The egoist might ask Kohn, "If the resultant pleasure is not the incentive, then what is?" Kohn responds that there are "prosocial actions which bring no apparent satisfaction to the actor" (p. 210). If that is the case, is altruism the unique case of unreinforced behavior?

This book is recommended for all those who think about human nature, who wonder whether people are basically self-serving or other-serving, who want to test their biblical view of human nature, and who want to delve into an analysis of motivations behind human behavior, including their own.

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

WHY AMERICA DOESN'T WORK by Chuck Colson and Jack Eckerd. Dallas: Word Publishing, 1991. 227 pages, notes, index. Hardcover; $16.99.

The authors are well-known and articulate citizens. Colson is the chairman of Prison Fellowship. Eckerd is

founder of the Eckerd drug store chain and is chairman of the Eckerd Family Youth Alternatives program. He was also founding chairman of P.R.I.D.E., Florida's unique prison industry program.

The authors' point seems to be that America will not turn around until it takes a new attitude toward work. One's initial impression is that most of the ideas set forth are not new: welfare programs create dependency and disdain for honest toil; schools don't teach basic American values, and efforts to change are fought by the NEA and the tenured teachers and administrators; students do not learn employment skills; American industry produces inferior merchandise; and morale in American prisons is low because most inmates have little or nothing to do—blamed in part on unions.

They are not able to say exactly when and how American's attitudes toward work deteriorated, but they trace it at least to the late 19th century, and they say that the vanguard of the revolution which resulted in the demise of the work ethic "invaded college campuses and swept through every area of popular culture in the '60s" (p. 42). The book is interesting, not because of the basic ideas presented, but because of the abundance of examples and illustrations. Specific examples include faulty automobiles produced by American companies and extensive waste in the U. S. Postal Service.

The authors say that without work most people would go crazy. One illustration is of a German prison camp where the commander forced inmates to do meaningless work day after day. Dozens went mad and committed suicide, some by flinging themselves at the electrical fences. The commander was pleased. The authors add that "the infamous chain gangs of the '30s were more humane than forcing inmates to sit day after day staring at concrete walls and go mad (p. 119).

Colson and Eckerd use other prison examples to emphasize the role of work in mental health. Most Soviet prisons have six-day eight-hour-per-day work programs. They describe a women's prison where there was a garment factory operation. The women, they note, "appeared alert, interested in their work, some of them almost cheerful" (p. 12). "It was evident," they say, "that morale was high in this place." They add that Solzhenitsyn said "manual labor in prison gave his life purpose." Then they make this observation: "The hope, industry and productivity that had disappeared from the streets of Moscow seemed to be alive and well in the Soviet prisons." They give other examples including successful American prison work programs.

One section in the book is devoted to the American educational system. They mention the efforts of Dr. Louis Sullivan, secretary of health and human resources, to teach young people the necessity of working hard and taking responsibility for the quality of their work (p. 88). But they criticize the National Education Association and other professional groups for opposing any attempts to prepare students for the work opportunities that exist today. Bright spots are mentioned. One of them is the Oregon Educational Act for the Twenty-First Century. Students in the 10th grade would be steered toward either a college preparatory program or vocational training.

Much of the book is devoted to examples of industries which have overcome the trends of the times and have given their employees pride in their work and in their companies. Much has to do with training and involving everyone from top to bottom.

Perhaps the authors have tried to cover too many bases. However, the numerous illustrations and examples are interesting and useful to one who already is in agreement with the authors, especially on such opinions as the following: "Aid to Families with Dependent Children is the real villain in the welfare system."

In brief, the authors would like to see work-for-pay jobs in all prisons, vocational training for most students, old-fashioned core subjects required in all schools, participative management in most businesses, and perhaps most of all an understanding of the truth that "the loss of the work ethic begins in the hearts of people ... in the values that motivate or fail to motivate them" (x).

Who should read this book? Probably those who admire Chuck Colson, Jack Eckerd, and Clarence Thomas, all strong believers in the work ethic.

Reviewed by Ralph C. Kennedy, retired, John Brown University, Siloam Springs, AR 72761.

THE PURSUIT OF HAPPINESS by David G. Myers. New York: William Morrow & Company, 1992. 331 pages. Hardcover; $20.00.

Although this book has a 1992 publication date, Myers has obviously been thinking about happiness for many years. One of the chapters in his (with Malcolm Jeeves) *Psychology Through the Eyes of Faith*, published in 1987, is titled "This Way to Happiness." The skeletal ideas which appear there are here fleshed out with data extracted from sources listed in 43 pages of bibliography. Myers' purpose in writing this volume is "more to inform than to prescribe or advise."

The book answers some intriguing questions about happiness: Is happiness rare? Can money buy happiness? Does age affect happiness? Are men happier than women? The answers to these questions (no) and many others are catalogued. A useful and succinct epilogue summarizes the true and the false about happiness. Some myths: tragedies permanently erode happiness; the elderly are the unhappiest people; women typically suffer an empty-nest syndrome; men typically experience a traumatic mid-life crisis; one sex is happier than the other; trial marriages reduce the risk of later divorce; and religious faith suppresses

happiness. Some truths: happiness is promoted by health, positive self-esteem, optimism, outgoingness, supportive friendships, challenging work, and an active faith.

Myers is a social psychologist, an award-winning teacher, a recipient of the Gordon Allport Prize for research, the author of eight books, a Christian, and a member of the American Scientific Affiliation. He is certainly one of today's most popular and readable writers. This book will appeal to anyone who wants a grip on the variables related to happiness — and that will include most people.

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

WHO AM I? WHAT AM I? Searching for Meaning in Your Work by Calvin Redekop and Urie A. Bender. Academie Books, Zondervan, 1988. 316 pages.

When I was a student I lived with my paternal grandparents. That experience made me very aware of the pattern of my grandfather's working life in Canada as a youth in a large family with few marketable specialized skills.He was thankful when he found steady work, especially during the depression years when he was able to provide for his family by dint of diligent effort.

My own experience has been very different. The struggles about work that my wife and I face have to do with choosing among a surfeit of opportunities, and keeping commitments to work in some sensible balance with commitments to family and church. We are better educated and more affluent than our parents and grandparents, but we share with them a struggle about work. We too have problems, but very different problems.

Although my particular experience is not universal, the authors of this book point out that work is changing in many ways—the types available, the amount available, the remuneration for it, its impact on humans, and the implications for society are all different than in the past. They set out to produce a "first word" on a Christian perspective on work, and to invite dialogue in response to their efforts. Their approach is informed by the social sciences, and seeks to be aware of our partnership with God in work—God's work is ultimate, human work is not—and to be aware at the same time of the humanness of the environment in which we carry out our work.

Difficulties about work arise for many reasons: there is a tension between recognizing the goodness of work and wanting to minimize the hardship associated with it; many jobs are "too small" for the people doing them, and are thus boring and demeaning; meaningless work can lead to alienation, although the authors suggest that there are so many needs in the world that nobody should have to do alienating work; increasing professionalization of work means that norms are determined by the group rather than the individual, and this can lead to conflict; many feel mastered by their work rather than masters of it. What is needed is a moral response to work, something based on standards brought to bear on this aspect of our lives from outside it, since society cannot be corrected from within.

Reading this book is a stimulating experience. There are times when its responses seem unsatisfying, although in many areas of life perhaps it is necessary to stop at general, seemingly vague, truths. It is a good first word. At the end of the book, the reader shares the authors' hope that more will be said — that others will participate in this dialogue.

Reviewed by David T. Barnard, Associate to the Vice-Principal (Resources), and Professor, Department of Computing and Information Science, Queen's University, Kingston, Ontario, Canada.

Books Received and Available for Review

(Please contact the Book Review Editor if you would like to review one of these books.)

N. Cameron, *The New Medicine: Life and Death After Hippocrates*, Crossway
J. Chirban, (ed.), *Health and Faith: Medical, Psychological and Religious Dimensions*, University Press of America
J. DeOnis, *The Green Cathedral: Sustainable Development of Amazonia*, Oxford
C. Gay, *With Liberty and Justice for Whom? The Recent Evangelical Debate Over Capitalism*, Eerdmans
N. Geisler, *Miracles and the Modern Mind: A Defense of Biblical Miracles*, Baker
S. Goldberg, *When Wish Replaces Thought: Why So Much of What You Believe is False*, Prometheus
G. Habermas & J. Moreland, *Immortality: The Other Side of Death*, Nelson
W. Harwood, *Mythology's Last Gods: Yahweh and Jesus*, Prometheus Press
T. Hill & D. Shirley, *A Good Death: Taking More Control at the End of Your Life*, Addison-Wesley Publishing Company
L. Lowry & R. Meyers, *Conflict Management and Counseling*, Word
H. Margenau & R. Varghese, *Cosmos, Bios, Theos: Scientists Reflect on Science, God, and the Origins of the Universe*, Open Court
R. Numbers, *Prophetess of Health: Ellen G. White and The Origins of Seventh-day Adventist Health Reform*, Tennessee Univ. Press
D. Overbye, *Lonely Hearts of the Cosmos: The Story of the Scientific Quest for the Secret of the Universe*, HarperCollins
E. Paul, *Science, Religion and Mormon Cosmology*, University of Illinois Press
W. Rusch, Sr., *Origins: What is at Stake?*, Creation Research Society
L. Swindler, *The Meaning of Life at the Edge of the Third Millennium*, Paulist Press
A. Tilby, *Science and the Soul*, SPCK
C. Woteki, *Eat for Life: The Food and Nutrition Board's Guide to Reducing Your Risk of Chronic Disease*, National Academy Press
R. Wuthnow & V. Hodgkinson, *Faith and Philanthropy in America*, Jossey-Bass

Letters

On Siemens' "Some Relatively Non-Technical Problems With Flood Geology"

Dr. David F. Siemens, Jr. presented several "Non-Technical Problems With Flood Geology" which creationists can, I think, solve rather easily.

Siemens asks what carnivores ate after the flood; what koalas ate; how the flightless moas reached New Zealand; how slow-moving warm-weather salamanders reached Americaa from Ararat across Siberia; and why some animals are found worldwide and others only in certain regions (e.g. most marsupials in Australia.)

In order to embarrass creationists, these questions must presuppose fixity within species, e.g. that koalas have, since the ark, needed eucalyptus, carnivores meat, salamanders temperate water, and moas been flightless. (Fixity *of* species is a different matter.) The Bible, on which creationist rely, presents significant change within species. "Upon thy belly shalt thou go" for the serpent (Genesis 3:14) and "the lion shall eat straw like the ox" (Isaiah 11:7, 65:25) are two instances. The descent of "red and yellow, black and white" people from Adam and Noah is another (more trivial) example. Creationists may well speculate that there were no carnivores until sometime after the flood, and little or no putrefaction. (Dr. Morris can change his mind.) Salamanders have had more than 420 years to get here from Ararat, and may have lost some of their original capacities by microevolution.

Given small initial populations at Ararat, providential ("random") movements could have had substantial impacts on later distribution, especially given somewhat limited time — thousands rather than millions of years.

Dr. Morris's population math may be too simple, but according to the Bible, life spans right after the flood were much longer than later life spans, so a quick population burst of long-lived prolific people in fertile Mesopotamia, followed by slower growth as the earth was filled, and then fairly slow growth until technology began to invite larger populations, is plausible.

"Careless" contradictions can be corrected, as Dr. Siemens appears to recognize.

Evolution would seem to present difficulties with which Dr. Siemens, by criticizing Dr. Morris without presenting alternatives, does not deal. How *did* New Zealand get flightless moas? If opossums have been around for millions of years, why have they expanded their range in this century? I'm sure he can present possible answers, as I have done, but I'd be curious to know what they are.

Andrew Lohr
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Lookout Mountain, GA 30750

Should We Start With More Basic Misconceptions Than Wonderly Did?

I heartily concur with the sentiments expressed in Daniel E. Wonderly's communication in the June 1992 issue of *Perspectives* concerning the need to warn Christian leaders about erroneous "scientific creationist" stories. In addition, I see a need to make such people aware of the real evidence for creation.

However I am dubious about the likelihood of success for such an endeavor if we begin by attempting to expose a story about the origin of coal deposits, especially if we are trying to convince someone with little knowledge of science. Rather I believe that we should begin with the most basic and easily comprehensible topics and then, after the groundwork has been laid, move on the more special examples.

I am particularly concerned about the following common misconceptions:

1. The idea that the total alteration of the earth's surface by the Flood is taught by or even consistent with the Scriptures;

2. The assumption that the short-day interpretation and other "scientific creationist" assertions were the unquestioned beliefs of the early church;

3. The impression that the proponents of such views are eminent scientists with advanced training in the subjects they discuss;

4. The absolutely ludicrous suggestion that the proponents of Big Bang cosmology have atheistic motivations, and

5. The accusation that people who accept the estimate of the earth's age indicated by science are sure to accept all theories in the area of science that have widespread popularity.

Some nontechnical discussion of these issues should be possible and, if understood, should serve as a basis for correcting many other common misconceptions.

Gordon Brown, Ph.D.
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The locations of Indices for previous volumes are listed on the inside back cover of the Journal. Numbers in each entry refer to volume, issue, page number, month, and year. (For example—42:4, 190, D 1990—refers to volume 42, issue no. 4, page 190, December 1990.) The names in parentheses under the Book Reviews are the names of the book reviewers.

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Communications

Dialogue

Essay Reviews and Biographical Sketch

Features

Reports

Book Reviews

WHAT EXACTLY IS THE AMERICAN SCIENTIFIC AFFILIATION?

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THE CANADIAN SCIENTIFIC & CHRISTIAN AFFILIATION was incorporated in 1973 as a direct affiliate of the ASA, with a distinctly Canadian orientation. For more information contact:

Canadian Scientific Affiliation
P.O. Box 386
Fergus, Ontario N1M 3E2 CANADA

The American Scientific Affiliation

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Canadian Scientific & Christian Affiliation

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

LOCAL SECTIONS

of the ASA and the CSCA have been organized to hold meetings and provide an interchange of ideas at the regional level. Membership application forms, publications, and other information may be obtained by writing to: American Scientific Affiliation, P.O. Box 668, Ipswich, MA 01938, USA or Canadian Scientific & Christian Affiliation, P.O. Box 386, Fergus, ONT N1M 3E2, CANADA.

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Vol. 16-19	(1964-1967),	Journal ASA	19,	126-128	(1967);
Vol. 20-22	(1968-1970),	Journal ASA	22,	157-160	(1970);
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Vol. 36-38	(1984-1986),	Journal ASA	38,	284-288	(1986);
Vol. 39-41	(1987-1989),	Perspectives	42,	65-72	(1990).

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