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Modern science began in Christian Europe, and many great scientists in past centuries viewed their scientific work as thinking God's thoughts after Him. This attitude toward science and religion went into a serious decline, until it seemed that science had eliminated the possibility of theology as a source of knowledge. However, more recent thinking by philosophers of science has set the stage for suggesting a different view. We will be dealing in this paper with biblical Christianity, and will not discuss other religions.

Christianity and the origins of modern science

At times in history scientific study was much more alive in other places than it was in the Western world, so why did modern science arise in Western Europe instead of in China or some other place? There is reason to believe that Christianity provided the ideal culture for the origin of modern science (Polkinghorne 1994, Ratzsch 2000). The creation of the universe by a rational, intelligent God explains why the universe is so intelligible and open to our scientific investigation. Since Christianity offered such a rational God, this can explain why Christians expected the world to be understandable, and why it is worthwhile investing one's energy and time into systematic investigation of nature. Science must also assume that nature is uniform, with universal processes and patterns. For a Christian, these characteristics and assumptions of science are founded in belief that the universe was created by a rational God who is faithful and consistent. A secular scientist does not have such a foundation, and must generally accept these concepts as mere assumptions.

Science as an institution has now rejected the creation account as its foundation, but continues to be successful. Will denial of the existence of a rational Creator eventually weaken science by undercutting its foundation? Or now that science is in motion does it have sufficient

momentum to maintain its rapid progress? Time will tell.

The philosophy of science - changing views on how knowledge is acquired and evaluated

As modern science developed in the 17th to early 20th centuries, scientists and philosophers encouraged a more objective and rational study of nature, by empirical observation, than had been practiced before. I will refer to Francis Bacon's understanding of science as an example of the traditional, positivist understanding of science developed early in that process. He thought that prejudices or theories are bad and should be avoided. Our task, according to Bacon, is to rid our minds of prior prejudices and theories, and then objectively collect data and let the data lead us to a true understanding of nature (Popper 1963, Ratzsch 2000). Bacon's concept of science is now understood to be unrealistic, and the most naive part of Bacon's philosophy was his belief that we can begin the scientific process by purging our minds of all bias or prejudices (Popper 1963). How would we know what ideas to purge? In actuality a mind purged of all "biases" would be an empty mind, not an objective mind.

In the positivist philosophy of science two important issues were demarcation (determining the boundary between science and nonscience) and confirmation of theories (how to determine if a theory had been demonstrated to be correct, or verified). In the early 20th century logical positivism was the most influential school of thought. According to logical positivism the confirmation of a theory can occur only by empirical data that verify, or indicate the truth of the theory. A theory is valid science, satisfying the demands of demarcation, if it can be verified by empirical observation. Everything that could not be so verified was nonsense. Thus science was considered the only route to understanding; all other knowledge was not knowledge at all. This materialistic outlook considered the material and physical to be real, but there could not be any human religious or ethical knowledge unless such knowledge was independently verified by science (Murphy 1990; Ratzsch 2000).

Positivism declined as it became evident that it could not effectively deal with some areas of reality, and that the verification criterion did not work. Karl Popper led the way in emphasizing that just because a series of observations support a statement does not finally establish it to be true. We never know when new observations may demonstrate the statement, or at least part of the statement, to be false (Popper 1959, 1963; Ratzsch 2000). We may hypothesize that all crows

are black, and support the statement by observation of 1,000 black crows, but then finding one white crow can prove the statement to be false. Of course most scientific theories are more complex than the color of crows, but no matter how simple or complex they are we can never verify a theory or demonstrate it to be true, because there is always the possibility that it may in the future be falsified by new data.

In Popper's philosophy of science, research begins with some observation or problem to be solved. Then the scientist thinks of a theory to explain the observation, and indicates what type of data would disprove, or falsify the theory. As long as research does not falsify the theory, it remains viable. Thus we cannot truly verify theories, but we can identify false theories and by this process gradually improve our understanding of natural phenomena (Popper 1959, 1963). Popper's philosophy answers the big questions of demarcation and verification in the following way. Any theory or hypothesis is scientific (meets the demarcation criterion) if it can, at least in principle, be tested, that is if it can be contradicted by empirical data. The confirmation criterion cannot be met by proving or verifying a theory, but simply by holding a theory only as long as it hasn't been falsified.

Popper's falsification concept was an improvement over positivism, but falsification also has its limits. New data may appear to refute a theory, but further research may reveal that we misunderstood that new data, and the theory was not falsified after all. This is a very real problem, since it is not possible to falsify a theory with confidence. However, in principle the concept of testing a theory by observations or experiments that have the potential to falsify it is still an effective technique, as long as we remember that falsification is not final. As our knowledge grows we may discover that the theory was actually not falsified. Science is always a continuing search, that doesn't reach absolute truth.

Popper's philosophy of science abandoned the rigidly rational criteria of the traditional view, and recognized the human element in science. He saw that there is always a need for human choice or judgment in research (Ratzsch 2000). Science was no longer seen as resting on a solid foundation, but was compared by Popper (1959, p. 54-55) to a building erected not on solid bedrock, but on piles driven into a swamp. They are not driven down to any natural base, but are driven in until "we are satisfied that the piles are firm enough to carry the structure, at least for the time being." In this new view of science it was no longer reasonable to claim that topics outside

of science were nonsense.

The human element in science became even more evident in the philosophy of Thomas Kuhn (1962, 1970), that "has placed humans and human subjectivity (in the form of values of the community of scientists) in the center of science" (Ratzsch 2000, p. 50). Based on his study of the history of scientific theories, Kuhn concluded that scientists do not generally try to disprove their theories. Rather each scientist typically works within a scientific paradigm (a broad, explanatory theory; e.g the theory of evolution). They do not try to test the paradigm, but assume it is true and use it to guide their exploration of new phenomena within the paradigm's domain. This process Kuhn called normal science, because that is what scientists normally do.

As normal science progresses, anomalies may be discovered - phenomena that do not seem to fit the expectations of the paradigm. If these anomalies persistently defy efforts to resolve them, this can lead to what Kuhn called a crisis state for the paradigm. Science never abandons a theory or paradigm without another one to replace it, but a crisis may stimulate a few creative scientists to develop an alternate paradigm. At that point it is not clear which paradigm is correct, and the choice between the old paradigm (which has only failed with a few problems) and the new one (which has not yet established a track record) is often made for less than objective reasons. Such choices can even be described as a "conversion" process that leads a scientist to see things in an entirely new and different way from how he/she saw them before (Kuhn 1962, 1970). If the new paradigm replaces the old, a scientific revolution has occurred, and normal science now proceeds under the new paradigm. The revolution process cannot be defined by rigorous logical criteria, but as the result of a changing consensus of opinion among scientists working in that field.

Further philosophical work has resulted in criticisms that parts of Kuhn's philosophy are not adequately supported by historical data (e.g. Laudan 1977), but it is still recognized that science is influenced by subjective human elements. Kuhn has responded to his critics (Kuhn 2000), and there were other important philosophers of science in the 20th century (e.g. Reichenbach 1951, and Feyerabend 1978, 1987). Feyerabend (1978) went so far as to urge that we should not try to define a scientific method, because rational boundaries defined by a scientific method will inhibit progress toward finding some legitimate new knowledge. We will briefly consider the works of Laudan (1977) and Lakatos (1978), who have provided sophisticated contemporary philosophies of science. Moreland (1989) and Ratzsch (2000) have written helpful analyses of the philosophy

of science from a Christian perspective.

Lakatos believed the history of science is best described as competition through time between competing research programs. A research program consists of a core theory, and a set of auxiliary hypotheses. The core theory is central to the research program, and is protected from falsification by the "protective belt" of auxiliary hypotheses, in order to give the core sufficient opportunity to be fully developed. When potentially falsifying data appear, it is the auxiliary hypotheses that are modified or replaced. The theory that all life has arisen by evolution is an example of a core theory, with its protective belt of changeable auxiliary hypotheses of specific evolutionary mechanisms.

A research program is considered progressive or degenerating according to several criteria, the most important of which is whether it is successful in predicting novel, hitherto unexpected findings, at least some of which can be successfully corroborated. Thus the choice between competing research programs is not based on our ability to determine which one is more true, but on the programs' relative ability to increase scientific knowledge. Both demarcation and confirmation are based on this relative success at increasing scientific knowledge. Science is still perceived as a rational activity, but it is now recognized that science is affected by sociology, economics, and other very human factors (Murphy 1990; Lakatos 1978).

The history of science shows that a theory may be successful in stimulating scientific progress, and consequently be widely accepted by the scientific community, and yet later be rejected because the accumulating evidence no longer supports it. Consequently, if at a given time there is a strong consensus among scientists regarding the truth of a particular theory, this consensus may result from philosophical or sociological factors, rather than from a body of evidence demonstrating the truth of the theory (Kuhn 1970; Lakatos 1978). For example, could the scientific consensus that all life forms resulted from evolution, result from a common anti-supernatural philosophical commitment, rather than from the adequacy of the evidence?

Laudan's (1977) philosophy of science has similarities with that of Lakatos, but he uses the term research traditions instead of research programs. A research tradition is also evaluated by comparison with other research traditions, on the basis of its ability to increase scientific knowledge by predicting novel, previously unexpected, findings waiting to be discovered by diligent researchers.

The decisions as to whose philosophical concepts (Bacon, Popper, Kuhn, etc.) are better have been made primarily from study of the history of scientific ideas, how the participants in science evaluated those ideas, and how they made their choices between theories.

Implications for theology

Since the Enlightenment, authority has no longer been accepted as a legitimate determiner of what is reliable knowledge. It could be argued that this has destroyed the rational credibility of Christian theism, since it depends on the authority of Scripture. This would appear to be true, unless we see reasons to believe that Scripture is worthy of more trust than human authorities.

The traditional, positivist, philosophy of science left no room for theology to influence science. The scholarly world still is generally skeptical of theism, but the views of philosophers of science in the 20th century have undercut rational objections to considering theology as a legitimate area of knowledge. Popper, Kuhn, Lakatos, and Laudan have revealed that science is influenced by many subjective human influences. They have also shown that the old demarcation and confirmation criteria don't work. There is overlap of science and other fields, and it is not possible to draw a sharp line between science and these other fields of inquiry (Moreland 1989; Ratzsch 2000). Theology and science are still, in important ways, quite different, but I believe there are reasons to propose that theology and faith can play a legitimate role in influencing science.

In fact Laudan claims that it may be "irrational and prejudicial" to exclude philosophical, religious and moral issues from scientific decision making (Laudan 1997, p. 132). The problem of evil, in the form of pain and suffering, according to Laudan, "is at its core an empirical problem *par excellence*: how can one maintain one's belief in a benevolent, omnipotent deity in the face of all of the death, disease, and natural disasters which are a daily element of our experience" (Laudan 1977, p. 190)? As we will see, the solution of this problem is crucial if theism is to be defensible to many people in this scientific age.

Laudan also argues that Judeo-Christian theology makes many historical claims about the existence of persons and the occurrence of events that should be testable by empirical methods (Laudan 1977). If it could be shown that ideas arising from theism, e.g., can be progressive in advancing scientific knowledge, then contemporary understanding of science would have

difficulty denying the validity of such ideas. Of course this interaction between science and religion must be carefully defined or it could be a source of problems, and we will now focus on this topic.

What should be the relationship between science and religion?

There are various ways to define the types of possible relations between science and religion (Barbour 1990; Peacocke 1993; Ratzsch 2000), but I am going to compare a set of three models for this relationship, based on how much allowance we make for religion to influence scientific thinking. These models will be:

1. *Isolation.* No relationship is allowed between science and religion; they remain isolated from each other. The philosophy of naturalism dictates that science reject any explanations involving the supernatural. Religion is at most an emotional experience and is not relevant to scientific issues.

2. *Parallel but separate.* This model seeks to understand the relationship between science and religion, because they are both accepted as sources of truth. However, religion is not allowed to influence science. The search for truth is not an integrated cooperation between religion and science, but religion and science remain separate, searching in parallel to each other. Science, in practice, follows methodological naturalism, which means that science, purely as a practical method, never considers any divine action as a possible explanation of any phenomena (although it does not deny the possible existence of god).

3. *Interaction.* This model encourages active interaction between science and religion in topics where they make overlapping claims, because both are accepted as sources of cognitive knowledge about the universe. Allow feedback between them, to encourage deeper thinking in both areas and provide an antidote to carelessness on both sides. Both religion and science can make factual suggestions to the other, which can be the basis for careful thought and hypothesis testing. This model respects the scientific process, but also recognizes truth in Scripture. It aims to be an open-ended search for truth, not bound by the rules of naturalism. Although it may

appear that the Christian using this model is bound by theistic rules, in actuality we do not need to fear that open-minded scientific study of God's nature, in the long run, will contradict God's message in Scripture - the Christian can afford to be fair with the evidence.

There aren't clear lines between these three models; there can no doubt be some options between these three, but the data in nature and in Scripture limit the number of viable options. A number of prominent writers can be confidently placed in one or the other of these models, and they will illustrate the differences between the models.

Model 1: Isolation

This first model isolates scientific explanations from any religious influence, and is characteristic of many authors who have written on the subject of creation and evolution. This entirely secular approach appears to be the closest to what could be thought of as an "official" description of science as practiced in the 20th century and the beginning of the 21st century. The philosophy of naturalism dominates this model, which does not allow science to accept any hypothesis that requires or implies any supernatural influence in the universe at any time in history.

Naturalism comes in two versions: philosophical naturalism denies the existence of god, but methodological naturalism does not make any claims against the existence of a god. It is just a method of science that does not allow explanations invoking miracles. In either case the practical result is the same; neither philosophical or methodological naturalism allow consideration of any hypothesis that implies, e.g., that life has been created by God, or that there has been any other divine intervention in history. This philosophy has at times been expressed very candidly: "If there is one rule, one criterion that makes an idea scientific, it is that it *must* invoke naturalistic explanations for phenomena, and those explanations must be testable solely by the criteria of our five senses" (Eldredge 1982, p. 82, emphasis in original). In a later book (Eldredge 2001) he softened that statement some, but the concept is still basically the same. Richard Dawkins (1986, 1996, 1998) is an outspoken advocate of the belief that life is the result of the blind forces of physics, with no purpose in mind. Some other anti-creationist authors avoid expressly advocating naturalism, but the material they present is clearly based on a theory of origins resulting from a

naturalistic scientific framework (Kitcher 1982; Futuyma 1995; Ruse 1996; National Academy of Sciences 1999). Following a naturalistic model to its logical conclusions implies that pain, suffering and death are a natural result of the laws of nature, and there is no other meaning for them to be found - we need to grow up and live with this.

So far I have only discussed this model from the standpoint of science, isolated from religious influence. The other side of the relationship is also important; what would religion be like if isolated from any scientific influence? I will not discuss this in detail, but it should be pointed out that scientific study has helped us to revise a number of ideas that were once a part of religious beliefs, and realize that they are not really supported in Scripture. For example we now recognize that species of animals are not fixed and unchangeable, and the sun does not revolve around the earth.

Critique of Model 1: Isolation

In evaluating this model, a critical question is whether science is an open-ended search for truth, wherever the evidence may lead? Or is it a game, defined by a set of rules, that seeks to find answers as far as it can go *within* those rules? For many scientists the relevant rules in the study of origins are defined by naturalism, and even if life was actually created by God, the rules determine that science can never consider that hypothesis, no matter what the evidence indicates. Creationists are often accused of being unwilling to allow their creationist beliefs to be considered as a hypothesis, subject to possible refutation by the evidence. My reply is - I will consider my creationist beliefs as a hypothesis to be tested, to the same extent that you will allow your naturalistic beliefs to be a hypothesis to be tested. I will argue that science as a rule-bound game that cannot consider some hypotheses is not a legitimate scholarly exercise. That may sound naive, but I am well aware that any quick refutation of either view will not be forthcoming - the universe is too complex to yield easy answers to such big questions. And in principle, modern understanding of the philosophy of science does not provide rational support for the exclusion of some hypotheses from consideration, even if those hypotheses will be very difficult for science to come to grips with.

The application of naturalism to the origins of life and of the diversity of organisms is being challenged by scholars in the Intelligent Design (ID) movement, led by Phillip Johnson and others

(Behe 1996; Moreland 1989, 1994; Dembski 1998, 1999; Johnson 1991, 1995, 1997, 2000; Ratzsch 2001; Dembski and Kushiner 2001). Advances in molecular biology make it increasingly difficult to justify excluding the hypothesis that life requires an intelligent inventor - that idea must be at least open for candid discussion. If science is going to be an open minded search for truth, it cannot arbitrarily exclude some hypotheses. A book by Pennock (1999) aimed to refute the scientific status of ID, and claims to have done so. However, for a creationist who accepts at least microevolution, speciation, and the evolution of languages within several created language groups, Pennock's book contains little or nothing in the way of substantive scientific arguments. It is primarily one long argument that naturalism is the only valid philosophy, and science is the only way to find truth. In written criticisms of ID that I have read, this type of philosophical rather than substantive scientific response is common.

Model 2: Parallel but separate

The writings of Peacocke (1993), Polkinghorne (1994, 1998, 2000), Barbour (1974, 1990) and Murphy (1990, 1997, 2002) will illustrate what I mean by the *parallel but separate* model. Murphy has doctorates in philosophy of science and in theology, and the other three authors are scientists as well as theologians. These writers don't agree on everything, but they share the same basic theology and approach to the relationship between science and religion. They believe in God as the ruler of the universe and, and in Jesus Christ as God's supreme revelation to humankind. They seek to understand God's revelation and how it gives us hope and salvation.

They also accept the entire theory of evolution and of the origin of life from non-living material as understood by science today. They agree that evolution through hundreds of millions of years has been God's method of creation, including the evolution of humans and apes from common ancestors (theistic evolution). In their belief system there was no literal Garden of Eden or Adam and Eve. There was no time when humans lived as innocents in a perfect paradise, and there was no fall into sin as many Christians believe. Although they don't discuss the concept of Satan, their theology does not seem to have any place for such a being. Evil, pain and suffering did not result from human sin, but are a natural part of the evolution process (death, disease, predation, extinction, etc. are seen in the fossil record for over 500 million years, in conventional geologic time, before human fossils appear; Fig. 1).

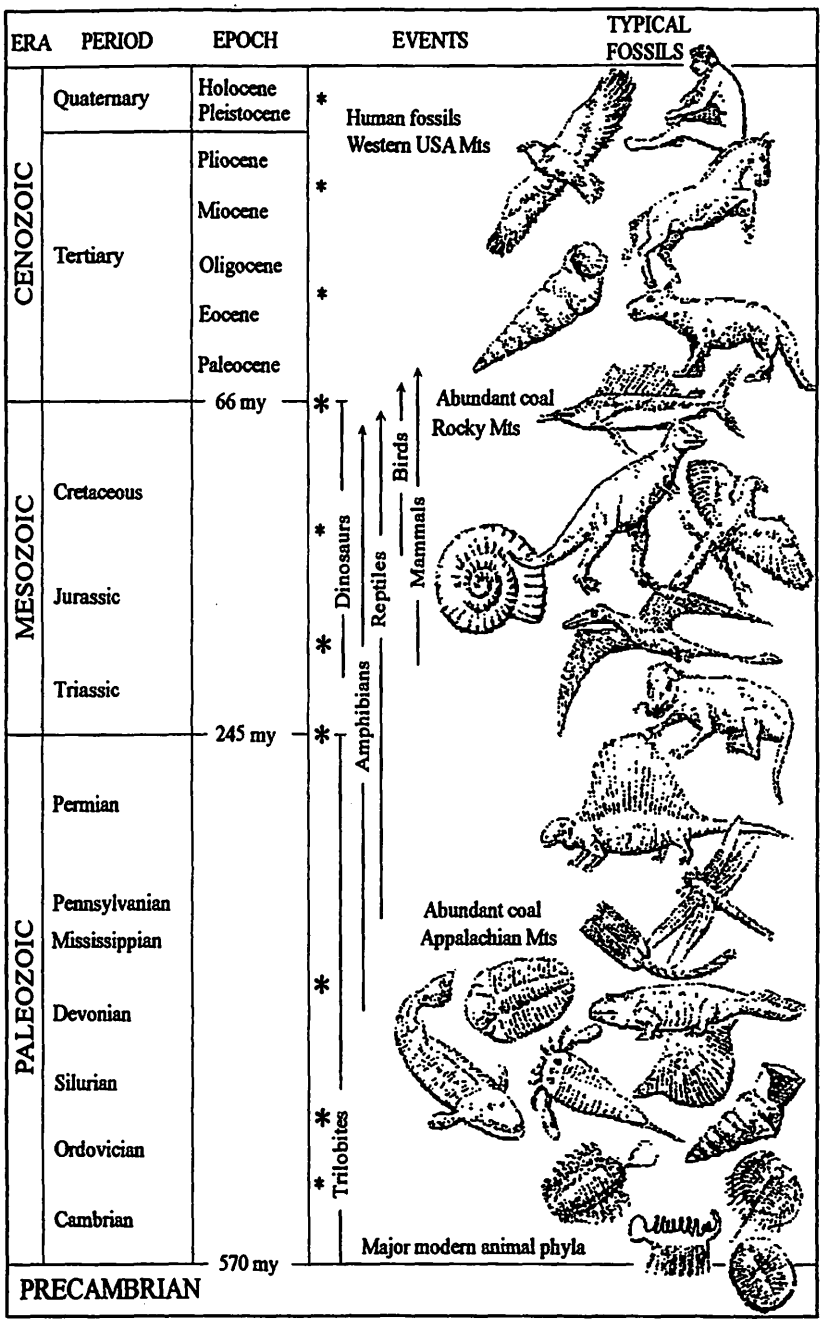

Figure 1. The sequence in which various groups of fossils appear in the geological column, with ages as determined by radiometric dating (from Brand 1997).

These individuals object to allowing religion to influence science. Even though they claim to be supportive of some version of a Dialogue or Integration model of the relation between science

and religion (Barbour 1990; Peacocke 1993; Polkinghorne 1998), they interpret this relationship very differently from my integration model. For them, science must proceed without interference, and religion seeks answers only to questions that science can't address. Religion and science are kept separate, but actually they are only *partially* separated, by a one-way door. In their system religion can learn from science, but science does not learn from religion, and religion does not "correct" science. The two are parallel in that both are taken seriously as a search for truth, but they are separate in that religion does not influence science. Thus they actually accept methodological naturalism, but are different from Model 1 in that they do see the search for religious truth to be a valid scholarly exercise.

But we can ask how this system can work, since Scripture and science in some cases speak to the same issues and say opposite things? Three examples are the creation of life, the creation of humans, and the fall into sin. Their answer is that it only *seems* like the Bible and science disagree, but we must understand that the Bible is only presenting spiritual insights. It is a serious mistake if we interpret the events literally. A phrase they often use to describe this situation is that Scripture is to be "taken seriously but not literally."

What does it mean to take something "seriously but not literally?" In any conversation regarding a topic that is not just emotional, but has some content, what would I mean if I take a friend's statements "seriously but not literally?" In that case I am in fact not taking him seriously at all, but am discarding his statements as unworthy of being believed, while giving his ideas some type of metaphorical interpretation, perhaps to avoid unduly embarrassing the person. If you are discussing with your teenage children the meaning of sex and the types of relationships in which sex will be constructive or not constructive, will you be pleased if they take you seriously but not literally?

There are some qualifications that are needed in this discussion, or it could be misunderstood. There are things in Scripture that even the most conservative among us will probably not read literally; for example the parable about Abraham and Lazarus (Luke 16:19-31). That parable has features that do not appear intended to be taken literally. The same could be argued for a number of other details in Scripture. In this paper I am concerned about basic Christian beliefs, not details.

Also, if a child comes running and tells us that the yard is washing away from a flood

(perhaps a broken water pipe), we may indeed take him seriously but not literally. Whether it is appropriate to take an oral or written statement seriously *and* literally will depend on our confidence in the level of understanding of the author of the statement. Whether we accept biblical statements about such things as a one-week creation event literally will be greatly influenced by our view of God's relation to Scripture. Is the creation week the naive understanding of Moses, or did God more directly instruct Moses, to be sure we are not misled about how life began? In other words, what is the nature of inspiration?

In taking Scripture "seriously but not literally" we are deciding that God has not committed Himself to reliable and trustworthy communication with us; that He has not taken the effort to communicate in ways that would convey timeless propositional truth for all eras of human history in spite of cultural differences (certainly the God of the universe has the wisdom to know how to do that if He chose to). The decision to interpret Scripture in this way has often been made on the basis that scientific conclusions are the standard for judging biblical statements, and scientific findings rule out literal interpretations of Scripture. In this situation I maintain that "Seriously but not literally" is a way to accept scientific conclusions about origins, rather than challenge those conclusions, while trying to salvage something from Scripture. But is this approach facing reality? If science is correct in all its conclusions about origins, is Scripture worth salvaging, or has the Bible's message simply been refuted?

This may not seem relevant to the philosophy of science, but it is relevant to epistemology in general - how do we find truth? In my reading in the sources cited in this section, it seems clear that the decision to take Scripture "seriously but not literally" even when it affects core Christian beliefs is based on contemporary scientific interpretations. If we believe science's conclusions that all life forms have resulted from a long evolution process, we cannot simultaneously believe that these life forms were literally created in the manner described in Genesis. The authors cited here believe that in any situation of this type, science trumps Scripture. But I suggest that the scientific tentativeness advocated by recent developments in the philosophy of science should encourage us to periodically reevaluate such a firm commitment to unquestioning acceptance of contemporary scientific interpretations. Otherwise we are descending into a realm of scientific dogma that cannot be questioned.

Our philosophy of science matters to a Christian, because it can strongly impact theology.

The application of the "parallel but separate" model has led to a theology that attempts to deal with the empirical problem of pain and suffering, but reaches a very different conclusion from traditional Christian thinking. We will consider whether that conclusion is worthy of being taken seriously (and literally).

In the references listed above for Peacocke, Polkinghorne, Barbour and Murphy it is accepted that life arose through the laws of nature, without the assistance of divine intervention, and life then diverged into many different categories of plants and animals through the action of "chance and law" - mutation and natural selection. They recognize that Darwinian mutations occur by chance, meaning that the mutation process does not know what the needs of the organism will be. Mutations just happen, for good or for ill, but then the natural selection process preserves mutations that are beneficial in that organism's environment, and weeds out other mutations.

These authors accept the scientific belief that this process has produced all of life, and has led to the evolution of conscious and then self-conscious beings, and finally to spiritually aware humans. This conclusion is, of course, contrary to a literal reading of Genesis, but they warn that any kind of literal reading of Genesis is a seriously defective view, and that Genesis must be taken "seriously but not literally." "Science can get on with its own task without needing a kind of spurious help from religion" (Polkinghorne 1994, p. 21-22). They advocate that theology, in this scientific age, must use the same criteria of reasonableness as science itself uses (e.g. Murphy 1990). Religion, they say, does not have access to any privileged source such as revelation. Genesis is only considered as "theological writing," and the Genesis story is a metaphor asserting only that "all that exists does so because of the will of God" (Polkinghorne 1994, p. 50). The Garden of Eden is an analogy of the innocence of our hominid ancestors before they became self-conscious and conscious of God. The biblical fall into sin was actually the turning toward self, after humans evolved to the point of being aware of God and of self (Polkinghorne 1998, p. 64), or "Adam's story is Everyman's journey from innocence to responsibility and sin" (Barbour 1990, p. 206).

How can this theology explain pain and suffering, disease, death, natural disasters like earthquakes and floods (natural evil), and cruelty, concentration camps, and murder (moral evil)? All four of these authors explain it in essentially the same way. They have concluded that if God

had imposed his will on the world, nature and humankind would not have been free. The only way God could give the world the gift of freedom was to let the world "make itself", allowing it to develop in its own way through the operation of chance and law - mutation and natural selection, and/or through the operation of the uncertainty (quantum mechanics and the Heisenberg uncertainty principle) that functions at the microscopic and sub-atomic levels. The uncertainties in these processes were what allowed freedom to emerge in nature generally, and in human freedom specifically. But the chance element in this process not only produced the freedom necessary to realize the full potential of self-conscious, God-conscious beings. The same process also of necessity produced the natural evil that is so destructive. The freedom and the evil came as a package deal, and "even god cannot have one without the other" (Peacocke 1993, p. 125). A new generation of life only arises through death of the previous generation, and this is the only way, in their evolution-derived living world, that higher levels of animal life can arise. This, they say, is the only way that humankind could originate, with our freedom and with all the pain and suffering that inevitably accompanied it, that not even God could prevent. "Most of the suffering in nature (that is not caused by us) is natural; it simply needs to be present in order for there to be life at all, especially for there to be life like ourselves" (Murphy 2002, p. 54). Barbour even says that "Christ was a focal point of God's activity and self-revelation . . . a new stage in evolution . . . part of the continuous process that runs back through *Australopithecus* and the early forms of life" (Barbour 1990, p. 211).

This concept has many theological consequences. Death and evil were not the result of any human action, since there was no Adam and Eve and no human Fall. Thus the classical explanation of the redemptive work of Christ in saving us from the effects of sin is not correct. Those stories are considered to be only mythological. These authors then explain that God does not walk away and leave us to suffer, but He suffers with us. Jesus hanging on the cross was God (but, for some authors, in a merely human form) suffering with us in our pain and suffering.

Critique of Model 2: Parallel but Separate

I see a series of problems that make the above scenario unsatisfying. First of all, their conclusion that pain and suffering are inevitable natural results if God allows us to have freedom depends entirely on their assumption that life is the result of evolution. But I have not found

evidence in the writings of these four authors to indicate an awareness of the weak points in the Darwinian theory. They make the mistake of accepting Darwinism as a package deal, without recognizing that different parts of the theory could have very different levels of support from the evidence. The evidence for microevolution and speciation is very convincing, but these authors also explain all increase in complexity of life as the result of law and chance - mutation and natural selection. The underlying genetic process in this proposed large-scale evolution depends on some important unsupported assumptions.

The laws of nature are critical for the existence and uniformity of the universe and the existence of life. However, life is also entirely dependant on another critical factor - the information coded in DNA and proteins. This information is like a series of written instructions for making biological molecules, and making them at the right place and right time. These instructions are like the words and paragraphs in this article - there is no law in nature that specifies whether D should come after E or H should come before M. Such order in DNA or on this page only results from the operation of intelligence - the information has to be invented.

Evolution claims that mutation and natural selection can accomplish the same result without intelligence, but this is strictly a hypothesis, and is the most serious weakness in evolution theory. Natural selection can only accomplish anything constructive if mutation just happens to provide the *right* mutations *when* they are needed, and it is not at all clear that this is a realistic hypothesis (Spetner 1998; Brand 1997; Behe 1996). The natural genetic changes (e.g. resistance to insecticides) or laboratory mutations often cited as evidence for evolution of new features tend to turn out, on closer inspection, to have other explanations (Spetner 1998) that are not consistent with the evolution of new biological information.

The history of science shows a series of apparently well-supported theories that changed considerably or were rejected because of accumulation of new evidence. Has that self-correction process ceased, and are our current biological theories in no danger of being refuted? Peacocke, Polkinghorne, Barbour, and Murphy may be building their theology on a scientific basis that will eventually leave them sitting on shifting sand.

Their belief that God can only give us freedom through the operation of the uncertainties of the sub-atomic world of quantum mechanics and/or the operation of chance in mutation and natural selection, is strictly an assumption. What evidence do they have that there is any

connection between these chance processes and the freedom of choice exhibited by humans, or any other type of freedom in nature? It seems likely that free will operates through the features God built into the amazing complexity of our brain cells. Freedom is the result of a brain invented by a super genius.

The world of cancer, earthquakes, accidents, death, child abuse, and Auschwitz is not "free" at all; it is just dysfunctional. If evolution, with its inevitable result of pain and suffering was God's way of creating, this says that God was not able to use a better system. Such an impotent god did not know how to design and construct a brain capable of making free choices, and was not able to make a world that originally functioned harmoniously, as described in Scripture. I propose that either the basic concepts in Genesis should be accepted as the true and literal description of the history of life on earth, or else I have to wonder why Scripture and its "god" would be interesting to me at all. If such a god was hanging on the cross in solidarity with our suffering, is he worthy of my worship, or merely of my pity? The conclusions reached in this *parallel but separate* model do not come from Scripture, but are imposed on Scripture by a particular philosophy of science and religion.

Those who have proposed this theology have thought through the issues very carefully, and have described the theology that logically follows if the fossil record resulted from the evolution of life forms over many millions of years (theistic evolution; progressive creation also leads to substantially similar theological conclusions), rather than a literal creation week followed by the Fall into sin, and later by the geological catastrophe described in Genesis. I cannot fault their principal conclusions, *provided their philosophy is correct*. But is their approach the only intellectually respectable way, or is there a viable alternative? We will consider this next.

Model 3; Interaction

Many scholars of this generation, including committed Christians, have rejected any notion of encouraging active interaction between science and religion. I understand their reasons for this, and I also reject some common types of interaction. Moreland (1989) and Ratzsch (2000) discuss some of these problems also. However, I hope to convince you that there is a better way for such interaction to proceed, that avoids the pitfalls, real or imagined, that can derail attempts to constructively integrate faith and science. Below we will take some time to discuss these pitfalls,

because understanding how to avoid such pitfalls is a key to defining a better integration method. We will then discuss the method by which I find that ideas from Scripture can in very practical ways contribute to scientific progress.

We will first compare the interpretation of Scripture in models 2 and 3. The interpretation of scripture used by scholars in the *parallel but separate* model is likely to include several or all of the following: 1) God may have impressed Bible authors to write, but He did not communicate to them the ideas or "facts" they wrote; 2) the human mind, in this age of advanced learning, is quite capable of judging the truth of biblical statements; 3) many of the "events" described in the Bible were symbolic or allegorical, not literal, historical events. Examples of the latter could include the 7-day creation, a global flood with an ark full of animals and people, the Israelites' miraculous crossings through two bodies of water, Jesus' miracles, Jesus' bodily resurrection, and a literal, personal devil. If this approach to Scripture is correct in its interpretation of core concepts of Christian theology, it would make little sense to look to the Bible for insights in earth history, or in many other scholarly areas of research.

The interaction model that I will propose takes Scripture more literally than Peacocke, Polkinghorne, Barbour, and Murphy are willing to do. This more conservative approach to Scripture can be briefly summarized with Ellen White's description of it, as "the language of the Bible should be explained according to its obvious meaning, unless a symbol or figure is employed" (GC 599). "It (the Bible) was designed for the common people, and the interpretation given by the common people, when aided by the Holy Spirit, accords best with the truth as it is in Jesus (5T 331). "A sense of the power and wisdom of God, and of our inability to comprehend His greatness, should inspire us with humility, and we should open His word, as we would enter His presence, with holy awe. When we come to the Bible, reason must acknowledge an authority superior to itself, and heart and intellect must bow before the great I AM" (SC 110). This approach accepts the events described in the Bible as actual historical happenings, including the miracles and God's literal communication of ideas and facts to at least some Bible writers such as Moses, Daniel, Paul, and John (not through verbal inspiration, but communication of thoughts).

The interaction model I am proposing will be of most interest to one who is at least willing to seriously consider the possibility that God has communicated some propositional truths to Bible writers, who have communicated them in language understandable to modern humankind.

My own area of training and research is in evolutionary biology and paleontology, and I will discuss the integration of faith and scholarship mainly in these fields, but similar principles could be applied to many other disciplines. In spite of current thinking in much of the scholarly world, I choose the more conservative approach to biblical interpretation as the more realistic one. This approach must be used with wisdom, prayer, and careful thought, or it can lead to simplistic ideas like a common fundamentalist belief in verbal inspiration of Scripture (which some SDA's have also tried to apply to Ellen White). I will not attempt in this paper to defend my conservative view of biblical interpretation, but will only discuss the application of that concept in integrating faith and scholarship, which I find to work very well.

Challenges to be overcome: the pitfalls

The attempt to integrate faith and scholarship introduces a tension. Religious belief, for a conservative, is based on authority, and there is a tension between authority and free inquiry. Are we willing to let the data lead where they will? The nervousness of Christian thought leaders about the idea of seeking a relationship between science and religion cannot be lightly brushed aside (Brand 2000). Any suggested method for interaction of science and faith must be developed with great care, and must have an answer for the following five concerns.

1. *Religion may introduce biases into our science.* Can religion introduce biases into our scholarly search for truth? It seems likely that it could. One solution is to decide that the Bible must be put aside when we think about science. Then religious biases will not trouble us, and we can be more objective. There is a problem with that solution, which is illustrated by an episode in the history of geology.

When the discipline of geology was taking form the geologists Hutton (1795) and Lyell (1830-1833) each wrote books in which they developed a paradigm of geology that rejected the catastrophism of their day (the belief that many rock formations were formed very rapidly; for some early geologists this was based on the Bible), and replaced it with the theory that all geologic processes occur very slowly and gradually (gradualism). Lyell's influential book constricted geology to a completely gradualistic paradigm until the mid 20th century. Historical analysis of Lyell's work has now concluded that the catastrophists in Lyell's day were the more unbiased scientists, and Lyell took a culturally derived theory and imposed it upon the data

(Gould, 1984).

Lyell's strictly gradualistic theory was bad for geology. It closed geologists' minds, preventing them from considering any hypotheses that involved catastrophic interpretations of geological data (Gould 1965; Krynine 1956; Valentine 1966). The authors just cited still prefer to explain geology in a millions of years scenario, but they are simply recognizing the evidence that many sedimentary deposits were catastrophic in nature. Lyell's paradigm prevented geologists from recognizing the evidence for these catastrophic processes until Lyell's serious bias was recognized and at least partially abandoned. The evidence for catastrophic processes was there in the rocks before, but if the ruling paradigm says it isn't so, it will probably not be recognized.

This episode reveals that bias is not a religious problem. It's a problem that we all have to contend with, no matter what philosophy we adopt. The idea that religion introduces biases, but scholarship that leaves religion aside is objective, is naive. We may read our pet ideas into the Bible, between the lines, and misunderstand how to relate Scripture to nature. However, those who do not take Scripture seriously (or literally) have their own problems with other biases, and these are no less significant than the biases that can result from religion. An effective model for integration of faith and science must include a bias-control process.

One factor that greatly affects a person's objectivity is their willingness to seek, and take seriously, input from others. If two persons with differing views are involved in the same type of research, they are each likely to notice things that the other may overlook. Consequently they will both probably be more successful if they seek to learn from each other. I believe that responsible efforts at integration of religion and science can contribute to this process, by the method described below, to the mutual benefit of both science and religion.

In summary, religion can introduce biases into our science, but so can any other philosophical approach. The answer is to be aware of the problem and consciously and critically analyze our efforts at being objective, and to communicate with others regarding our ideas. Awareness of different points of view on an issue generally improves our ability to recognize our biases and to reach a defensible conclusion.

The reverse of this is also true - if we *do not* seek to integrate science and faith it is unlikely that we will adequately understand the areas where science and religion speak to the same issues and seem to be in conflict. If we do not put forth serious effort to challenge conventional thinking

and develop a positive synthesis of science and faith, we are likely to accept conventional thinking without knowing whether or not it is based on a solid foundation.

2. *Science may disprove our Christian belief system.* There could be a fear that science will finally disprove our Christian belief system if we try to integrate faith and scholarship. Are we confident enough to accept that possibility? It is possible that some of our specific beliefs about origins that involve details not given in Scripture may be wrong, and it is better for us to learn that. Ideas that are truly God-given biblical truths, on the other hand, will not be disproved. Nature and revelation will not ultimately contradict each other, for both came from the same God. It is often more comfortable for us to keep our beliefs close to our hearts and not let science look at them, but if we do that we will miss opportunities for discoveries that can vindicate our trust in the Creator and help others to learn to trust Him also, while possibly also revealing that some of our ideas are wrong and not biblical.

Of course many would say that the above scenario has already happened - scientific data on such topics as the age of life on earth have already disproved the Genesis story. However, as we use science to study questions of origins and biological history, there is a danger that we should be aware of. Science has for so long used naturalistic thinking to explain all the data, that it takes diligent, careful study to see past those deeply-entrenched interpretations and find new ways to understand the data. Also scientific research typically does not yield its secrets quickly or easily. It often takes years of effort to resolve a difficult scientific puzzle, and only the persistent researcher will succeed. A researcher with a settled confidence in Scripture will at times have to stubbornly trust the God of the Bible until they finally are able to understand the data (and some of our questions will probably not be answered on this earth). That is what other scientists do when they face difficulties in finding a fit between the data and conventional scientific theory. They typically have confidence that the theory will ultimately solve its problems. That is why Lakatos's research programs include a core theory which is protected from disproof by the protective belt of auxiliary hypotheses.

Previous experience suggests that we will continue to find strong evidences of the Creator's hand in biological history and earth history, but we will also struggle with solutions to some difficult puzzles. Radiometric data, e.g., seems to point strongly to a very long time for life on earth, but some other evidence, in addition to Scripture, gives me reasons to question that age. I

believe there is reason for much continued study of this topic.

In summary, it is my observation that those who warn against attempts to integrate science and faith are often persons who do not believe that the Bible gives facts, but only "spiritual truths". On the other hand, if we have confidence in the truth of Scripture we don't need to fear honest research, but we must avoid superficial efforts or they could lead us in wrong directions.

3. *We may hold religious positions that are ultimately not biblical, and scientific disproof of these positions will discredit our faith unnecessarily.* The problem here is our tendency to read into the Bible, between the lines, our pet ideas, or ideas that have become culturally ingrained but are actually not in the Bible. For example in Darwin's time there was widespread Christian belief that all species of animals and plants were created just as they are now, with no change since the creation. In reality this idea cannot be supported from the Bible, but came from Greek philosophy, and the concept was "read into" such general phrases as "after his kind." Scientific research has produced abundant evidence that at least some biological change does occur, refuting this supposedly biblical concept and further weakening the faith of some persons.

Nevertheless, if we hold beliefs that are not biblical, don't we want to find that out? Scientific knowledge at any given time includes many beliefs that will later turn out to be false. That doesn't keep scientists from pursuing research, and ideally they readily admit when they discover new data that change some scientific belief (especially if it challenges some other scientist's beliefs, rather than their own!). Religious scientists can pursue research with the same confidence and openness to change in our humanly devised ideas about details that aren't given in Scripture.

Problems are caused by some creationists who devise very speculative theories about origins, that go way beyond what is given in the Bible, and proclaim these as TRUTH. When scientists encounter these careless and embarrassing theories it does make our faith look bad. The problem here is not the effort to integrate science and faith, but the careless and uninformed way that it was done. The solution is not fear of research or fear of the effort to integrate science and faith, but careful, well-informed study, and also an honest attitude in areas where we do not have adequate answers to difficult data.

4. *The danger of returning to god-of-the-gaps thinking.* Another concern is that we may drop back into the old god-of-the-gaps reasoning of an earlier era. In British natural theology of

pre-Darwinian times it was thought that the direct action of God should only be invoked in processes for which we cannot find a natural explanation (God can be found where there are gaps in our understanding). The problem with this approach is that as science found explanations for more and more processes in nature, these gaps were filled and God was pushed farther and farther away and finally dispensed with altogether (or so it seemed). In reality this was a logical fallacy, because to describe something does not explain it. Our increased scientific knowledge has increased our understanding of how God's marvelous inventions work, but has not shown how those inventions were produced or at what level God's sustaining hand still operates. The problem with the god-of-the-gaps approach was that as more scientific explanations were found, it tended to undermine faith in God. Thus the concern about falling again into the god-of-the-gaps fallacy is valid, and deserves an answer.

It is important not to fall back into that trap. It is not necessary to do so if we carefully examine our logic in our integration efforts. One difference today from previous centuries is that in some areas of science we have learned enough for our arguments to be the opposite of the god-of-the gaps. For example in molecular biology the more we learn, the more difficult it is to explain origins without a Creator. Instead of God being needed only where there are gaps in our knowledge, the more data we collect, the more evident it becomes that we need God in our explanations. In other words, some gaps are getting wider, not narrower.

In summary, fear of the god-of-the-gaps fallacy should not frighten us away from efforts to integrate science and religion into a meaningful synthesis. It is important that we be aware of the nature of various logical fallacies, like the god-of-the-gaps, and avoid them by careful self-evaluation of our logic and by paying attention to other scholars' criticisms of our ideas. Just because a task requires navigating around pitfalls is not a good reason to refuse to tackle the task. Ask any of the great explorers about that.

5. *Religious explanations ("God did it") may discourage scientific investigation.* An additional concern about integrating science and faith is that the conclusion "God did it" may eliminate any further need or incentive for scientific research, and consequently is bad for science. The way some persons approach this subject does have that effect. However, it does not need to be that way. A biblical position does suggest that some current scientific research is not worthwhile, but it can also suggest new approaches to research that can, and already are, resulting

in productive science. The examples discussed below illustrate this concept, and show how an active interaction between science and Scripture can challenge us to more careful and diligent research in both science and in our religion.

These new approaches result from asking questions that others are not asking; including questions that challenge or ignore assumptions based on a paradigm that denies biblical concepts. The assumptions of a discipline may be necessary to provide a framework for interpreting evidence, but if they are never challenged they may also have the side effect of protecting some concepts from rigorous thought and research. Many and perhaps all disciplines can benefit from careful scholarly work that digs deeper and seeks to identify significant questions that are not being asked.

Those who accept a non-creationist history of life, with life on earth for ~4 billion years have a tendency to argue that even if it is hard to explain the origin of life forms, the long time spans allow seemingly impossible things to happen. This can have the very same effect as relying on "God did it" to solve all problems. I will argue that relying on time to work the miracles is, for many persons, shielding the study of life origins from rigorous thought. Dawkins (1986, 1996, 1998) is a good example of this problem.

In summary, an effective method for integrating faith and science *must* encourage research in science and also more careful Bible study, stimulating growth of knowledge in both areas. That may seem like a tall order, but keep reading.

The interaction model for integration of religion and science

This model begins with the assumption that science is an open-ended search for truth, and is not willing to accept any rules that will restrict the search. Science as a game, following an arbitrary set of rules, does not interest me. One such arbitrary rule, the philosophy of Naturalism rejects any hypotheses that imply supernatural intervention in the universe at any time, past or present. But the absence of unique events (supernatural or otherwise) should not be assumed, but should be a hypothesis to be tested. If we wish to consider whether there were such interventions, and to examine evidence relevant to that question, naturalism must be set aside so that the search can proceed unhindered.

Nancey Murphy (1990) claims to have demonstrated that theology can use the scientific

method. She starts from the position that in this age of scientific reasoning theology must justify its knowledge claims by showing that theology's methodology is consistent with scientific reasoning. She chose Lakatos's philosophy of science as the most sophisticated one available, and applied it to her examination of "a theological school (the Roman Catholic Modernist movement from roughly 1890 to 1910) in order to see whether Lakatos's theory of scientific rationality allows for a reconstruction of the rationality inherent in its development" (Murphy 1990, p. 88). She showed that it is reasonable to interpret the Modernist movement and the development of its belief system as a core theory ("Genuine Catholicism is the true faith and reconcilable with modern thought") with a belt of protective auxiliary hypotheses. She showed how the core belief remained intact while the auxiliary hypotheses changed as various scholars developed the thinking of the Modernist movement. From this study she concluded that theology does meet the standard of scientific rationality as represented in Lakatos's philosophy of science.

It seems to me, however, that she missed the point in this research. Although Lakatos provides a convincing description of the scientific process, we don't accept the value of science because it follows Lakatos's method. We accept science because it *works* - it improves our understanding of how the universe functions. In the same way, showing that theologians follow a Lakatos-like method does not validate theology as a method for seeking truth. Theology is of value if it *works* in revealing convincing truths about God and human destiny. Murphy's research is only an analysis of the philosophy and sociology of religion, not of the application of theology to analyzing truth claims.

Murphy recognizes that her application of Lakatos's theory of research programs "is not as helpful as it might be in illustrating how the main business of theology is to be carried on in its light" (Murphy 1990, p. 175). Later she mentions how the theologian Pannenberg uses his theology to offer reinterpretations of data in anthropology. She says "the prediction and corroboration of some fact previously unanticipated by the anthropologists at this point would go a long way toward establishing the scientific respectability of Pannenberg's theology" (Murphy 1990, p. 178). This is the most relevant example of Murphy's thesis that theology can stand up to the standards of the scientific method, because Pannenberg made a prediction that can be tested by science, and thus can test truth claims. This case is an example of my own suggestion of how religion can suggest hypotheses or make predictions that can stimulate scientific research.

Murphy's approach differs most from mine in her claim that "In philosophy of religion the important point of contention is still whether it is *possible* to be a rational theologian. Here the game is won by anyone who can show that theology is in the same ball park with science . . ." (Murphy 1990, p. 208; emphasis in original). I answer that science is not the standard for judging theological method. Theology is of little value unless God has communicated truths to us, and if He did, then theology goes far beyond science and reveals things that science could never figure out on its own, while science helps us to see where we have read something into Scripture that isn't there.

Plantinga (1997) urges Christians to use all the information available to us, including what we know as Christians, in seeking an understanding of our scholarly disciplines. Others have also suggested that statements about the world can be derived from Scripture and can be tested by the methods of science (Moreland 1989; Ratzsch 2000). My purpose here is to develop that concept. The primary distinguishing features of this model are 1) science and religion challenge each other is areas where they are in conflict, motivating more careful thought and research in both areas. Religious concepts are not tested by science, and scientific concepts are not directly tested by religion, because we may misunderstand the information from both sources. By keeping them temporarily separate in our mind, and letting each persistently challenge the other we are forced to dig deeper in both science and religion and not accept superficial explanations. Other features of the model are: 2) religion can be a source of ideas, hypotheses, or predictions that can be a stimulus for scientific research, and 3) these ideas are pursued and tested with scientific research. The scientific process used will be the same as that used by others, and will differ only in the questions that are asked, the evidence likely to catch the researchers attention, and the range of explanations open for consideration. This is partly illustrated in Figure 2 (from Brand 1997).

There are definite limits to what science can do in this integration process. Science cannot study supernatural processes, such as creation, or Jesus' miracles. Science can only do research on events or processes that can be observed, or that have occurred and left evidence behind. If some unique event (miraculous or otherwise) has influenced such events, science can study any evidence that was left behind, and historical records could be used to make predictions regarding such events. It doesn't matter where those ideas and records came from (even from the Bible). The source of an idea or hypothesis does not influence the scientific legitimacy of the idea. If it

can be evaluated by the scientific process, it is a valid scientific idea (Popper 1959, p. 31, 32; Moreland 1989, p. 229; Cromer 1993, p. 148).

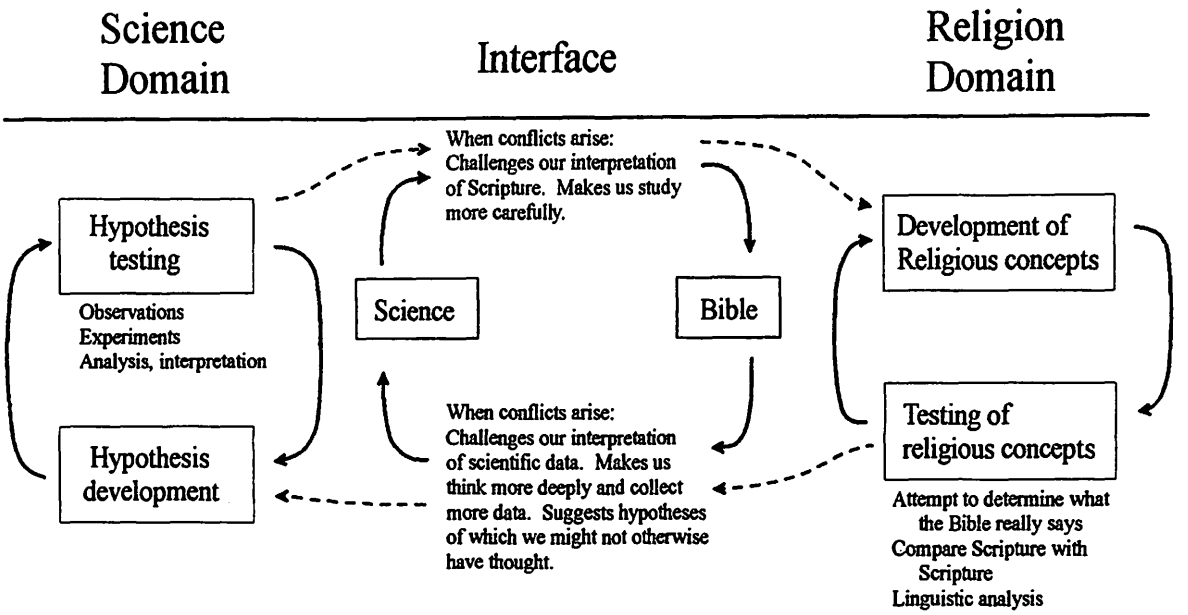

Figure 2. Illustration of a method for integration of science and religion. The methods of scientific research and of religious study are different, and the integration occurs in the thinking process called the interface. This occurs especially, but not only, when conflicts occur between science and religion, stimulating more careful research in both areas. Either science or religion can suggest ideas that can be utilized in scientific research.

It is necessary to know God as a personal friend and learn to trust Him and His Word, before we are likely to use Scripture to effectively assist us in our scholarly thinking. That step may seem too subjective to be part of a philosophy of science, but both science and theology must deal with subjective elements. The viability of this method depends on whether we can make it work to suggest testable predictions or hypotheses. Meanwhile if we interact with other scholars with various views, that interaction provides bias-control and can help us avoid simplistic attempts to relate Scripture to the natural world.

This approach is not just a theory, but some of us have been using it for years and find that it works very well. Incorporating the following steps is effective in achieving results while controlling the biases that can result from any world view: 1) actively search for and utilize insights from Scripture in developing hypotheses pertinent to our discipline, and pursue research attempting to test these hypotheses; 2) be aware of the work and thinking of those who have a different world view; 3) whenever feasible, submit our work for publication and peer review; 4)

become friends with those in a different world view, and perhaps even do collaborative work with them. This requires the confidence and independence of thought to not accept whatever our collaborators think, while maintaining a constructive dialogue that can reduce the likelihood of superficial thinking. A number of examples of this research approach could be described (e.g. see Brand 1997), but here we will consider just two examples.

Examples

Walls of Jericho - When the walls of Jericho fell down, as described in Scripture, the result would be a pile of rubble. If we can now identify the ruins of Jericho, we can study that pile of rubble. Science would probably not be able to determine whether the walls fell from an earthquake or from a divine push. However, before beginning the archeological study we could use biblical information to predict that the walls fell down suddenly, rather than disintegrating gradually through time, and then test this hypothesis or prediction with the methods of science.

Fossil whales of the Miocene/Pliocene Pisco Formation of Peru - The Pisco Formation in Peru contains a large number of fossil whales, buried in a deposit of diatoms and other sediments. Microscopic diatoms are organisms that float near the surface of lakes and oceans. Upon death their silica skeletons sink, and in modern oceans they form accumulations of diatomite a few centimeters thick in a thousand years. It is assumed that ancient (fossil) diatomite deposits formed at the same slow rate - a few centimeters per thousand years, which is consistent with radiometric dates indicating a time frame of several million years for the Pisco Formation. My biblical world view predicts that geological deposits like this formed in a much shorter time frame - a maximum of hundreds or thousands rather than millions of years.

Geologists have published on the overall geology of the Pisco Formation, and paleontologists have studied the whales and where they fit into evolutionary scenarios. Apparently no one has previously asked how it can be that sediment which accumulated at the slow rate of a few centimeters per thousand years can contain complete, well-preserved whales, which would seem to require rapid burial for their preservation. Our world view with its predictions of short time periods opened our eyes to see things that others have not noticed. When I saw the Pisco Formation the incongruity of the well-preserved whales as opposed to the presumed slow rate of

diatom accumulation hit me right between the eyes. Our research there during several summers, by a team of geologists and paleontologists, has indicated that the whale carcasses were not in any type of special situation that could favor preservation of animals over extended time periods before burial. Our evidence points to rapid burial, probably within a few weeks or months, not thousands of years, for any given whale, and suggests some processes that can help to explain how ancient diatomites may have accumulated much more rapidly than is usually assumed.

In this research we have presented several papers at the annual meetings of the Geological Society of America (attended by 5,000+ geologists and paleontologists) and at an international paleontological conference in Spain. These presentations provided opportunity for interacting with other scientists who deal with these topics. We have published two papers (Esperante-Caamano et al. 2002; Brand et al. 2004) and have several more manuscripts in preparation. The best scientists in the field have opportunity to evaluate our work, and will be eager to point out any mistakes. That is a powerful incentive to keep us from being careless. Of course we will not discuss biblical insights at the geology meetings or in our publications, as that would not be appropriate. We will discuss scientific work only, and if the data support our conclusions our work will stand up to the criticisms of scientific reviewers.

In the research described above our research method was not different from the method used by other scientists. The data potentially available to us, the data we used, the laboratory methods for analyzing samples (XRD, XRF, scanning electron microscopy, examination of thin sections, etc.) were the same as for anyone else. The only differences were in the questions we asked, the types of evidence most likely to catch our attention (primarily affected by the questions we asked), the range of possible interpretations considered (These will include a much shorter time frame than many scientists would prefer), and the predictions made by our worldview.

Our predictions and hypotheses must be tested in the same way as anyone else will test scientific predictions and hypotheses, and these tests will have to stand up to the normal scientific peer-review process. Although other earth scientists did not recognize the need to reevaluate the rate of accumulation of diatoms in the Pisco Formation, the reviewers of our manuscripts, in the fields of taphonomy and diatom studies, agreed that the data supported our conclusions.

It must be emphasized that this model does not introduce a different scientific process of data collection or analysis or data interpretation. The novel feature is simply taking Scripture as a

source of valid information, and using that information to *suggest new hypotheses* to be tested, and *new questions to be asked*, that we probably would not have thought of otherwise. It *opens our eyes* to see things that we might otherwise have overlooked. At that point it is then up to us to use science to rigorously test these novel ideas, and see if they will stand up to the best scientific procedures and bias control of peer review.

In the above examples information from Scripture influenced hypothesis-formation in science. The process also goes the other way. Experience in geology research has led some of us to recognize that a common assumption among conservative Christians is actually not biblical - the assumption that all or most of the fossil record formed during the global flood of Genesis. It is not unbiblical to suggest that part of the record formed before and part after the flood.

Theological implications of the interaction model

This philosophy for integrating science and religion yields a consistent, rational explanation for the origin of life and of pain and suffering. A conservative reading of Scripture portrays a cosmic conflict between God and a created being, called Satan. God created the universe and life to function harmoniously, and humans were initially innocent and sinless. But humans and other intelligent cosmic beings were not made as obedient computers; their brains were designed by God with the ability to make free choices. Satan and humans made the wrong choice, and sin, pain, and suffering for the human race resulted from this choice. The suffering thus initiated has affected not only humans, but their sin was also a choice to permit Satan to exert his influence on the earth and on all life on the earth. The ultimate result has been pain, death, disease, and changes in the geological structure of the earth, producing natural disasters such as floods, earthquakes, and storms. These were not punishments for sin, but were the natural result of sin and the allowing of Satan to exert his influence on the earth and its inhabitants. Jesus's death and resurrection in some way earned Him the right to redeem humans from their sin, and give the gift of eternal life, on a recreated planet, to those who accept the gift. This gift will be received when the cosmic conflict is ended and it has become evident that God's way is best after all. This is important because God honors our freedom of choice, including our freedom to choose to accept the consequences of our choice. In eternity He will not force us to obey, but the history of the cosmic conflict will convince those who have accepted eternal life that it would be foolish to rebel

again. These theological concepts cannot be studied by science, but they are the logical result of a particular philosophy of the relationship between religion and science. For me personally, the coherent explanation of pain and suffering resulting from my application of Model 3, in contrast with the explanation offered in Model 2, is a powerful argument in favor of the epistemological approach underlying Model 3.

Of course this philosophy requires that humans actually were created in a creation event that predated the formation of the sequence of fossils in the fossil record. If pain, suffering, death, and geological hazards like earthquakes and volcanoes resulted from human sin, then humans could not have evolved from ape-like ancestors near the end of geological history, but had to have been in existence from the beginning of life's history on earth.

This challenges some of science's contemporary interpretations, and predicts that a number of significant phenomena are yet to be discovered, especially in the areas of geology, paleontology, and radiometric dating. For example, as far as science understands, the earth's crust and the mantle that it rides on are very viscous, and only move extremely slowly - currently about 1-4 cm per year (Burchfiel 2004). This concept is often cited as evidence that a biblical time frame from creation to the present is impossible, because the rapid continental movements required by that time frame are impossible. But we are told that at the time of Jesus's return "The whole earth heaves and swells like the waves of the sea. Its surface is breaking up. . . Mountain chains are sinking. Inhabited islands disappear" (GC 636). Such crustal fluidity and rapid movement is very unrealistic if current geophysical interpretations are true. Yet God has told us that when He involves Himself in physical processes on earth, things may function quite differently from what we have observed in our lifetimes.

Also, when Jesus told a man with a withered hand to stretch it out, and it was healed, and when Jesus, at his arrest, healed the soldier's severed ear, God had to create healthy tissue at that moment. Majority scientific opinion would have us believe such a thing to be impossible. But if God has communicated trustworthy statements to us (and what other conclusion could be consistent with the way Jesus intimately related to us by His life?), then these statements about the crust of the earth and Jesus's instant creations support the interaction model for integrating religion and science. They do so by giving us insights into how far some physical and biological processes can vary from modern observed processes, when God brings His influence to bear on

them.

Many scientists object strongly to such proposed divine interventions that don't follow the normal course of natural processes. However, if these interventions did occur (and Scripture says or implies they did), is it better for science to recognize them, or to pretend they didn't happen? Perhaps the reason Scripture tells us about the creation and flood and gives us insights into the amount of time represented is because God knew we would have trouble correctly interpreting the complex evidence from the ancient past without these insights.

If we don't seek to learn from God's communications to us and even use them to inform our science, then science, not God, has priority in our thinking, and our science will lead us in incorrect directions. Our understanding of philosophy of science has direct relevance to this issue. Modern understanding of the philosophy of science reminds us that we cannot verify theories - science does not know for sure what are the limits of truth about the universe. It is not realistic for science to insist that its understanding of geophysics, e.g., is correct and complete, and that there are no new physical principles yet to be discovered - even principles as radical as rapidly moving continental crust. Science cannot at this time support such a hypothesis of rapid continental movements, but it also cannot legitimately deny the possibility that there might be undiscovered physical principles that would allow that hypothesis to be true.

Conclusions

It seems that Christianity with its rational, consistent God provided the context for modern science to develop. However, beginning with the Enlightenment science tried to define itself in a way that denies theology any legitimate right to influence science or even to claim to have knowledge. Twentieth century philosophers of science found the older philosophies of science increasingly unworkable, as they realized how human, science and scientists are. With this new realization that a clear line cannot be drawn between science and non-science, it has become unrealistic to deny theology as a possible source of knowledge. This opens the door to suggest that the integration of religion and science is a worthwhile goal. Religion can suggest hypotheses for science to think about, as well as the reverse.

In spite of these developments, many scientists interpret nature within the framework of naturalism - no hypotheses are allowed that would imply any divine intervention any time in

history. This philosophy does not allow any attempt to integrate religion and science. A second model for the relation between religion and science (parallel but separate) accepts both religion and science as sources of truth, but religion is still not allowed to influence science. As a result, living things, including humans, are believed to be the result of evolution. There was no Adam and Eve and no fall into sin. Thus the Christian doctrine of salvation also is rejected. Pain, suffering, and death are interpreted as the necessary result of the generation of life through evolution, and even god couldn't prevent that.

The third model (interaction) accepts both science and religion (Scripture) as sources of knowledge, and recommends an active effort to integrate them. When they conflict, this stimulates more careful study of both, seeking to understand them better and search for an interpretation that is in harmony with both. Since God has given us Scripture, it contains insights that go beyond what science can offer; insights that we would not likely discover with science alone. This model supports an interpretation of the origin of pain, suffering and death that is rational and consistent, in contrast with the other models.

There is an important relationship between religion and the philosophy of science, since an incorrect philosophy will lead us away from biblical truth, if we are logically consistent. A correct philosophy of science facilitates a constructive integration of religion and science, making use of all that we as Christians know from Scripture. We can even utilize that knowledge to open our eyes to potential new discoveries in science. Christians have an exciting opportunity to follow God's leading in this integration process, to demonstrate to a skeptical modern world that Christianity speaks not just to the emotions, but also reaches the mind and challenges it to reach beyond a mere human view of the universe, and to grasp a truly harmonious understanding of its origin and destiny.

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