HIERARCHY

Towards a Framework for the Coherence of Faith and Science*

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1. Introduction

This paper aims to present a view of scientific knowledge and its relation to theological knowledge and faith knowledge that is consistent with the Scriptures. It is based on a hierarchic or discontinuous view of the cosmos. This implies, among others, that it excludes large-scale evolutionary development from matter to man. It does, however, not exclude small-scale evolution. The two main reasons for developing such a discontinuous hermeneutic for biology are religious and scientific.

1.1 Religious Justification

I believe that there is a genuine conflict between faith knowledge and current scientific theories regarding the origin of man. Biologists claim that man has animal ancestors. The Scriptures reveal that man was created in the image of God, that he fell into sin and bears the responsibility for it. Moreover, man needs to be redeemed from sin, but is unable to do so by himself. Many Christians claim that both types of knowledge can be true and are unrelated to each other. They believe that God works providentially via large-scale evolution, and that this view of God's providence agrees both with biblical revelation and scientific knowledge. I believe that biblical revelation and scientific knowledge regarding the origin of man are related and are in conflict. To explain this we have to distinguish between two forms of theistic evolution. These forms are based on two different views of evolution, namely continuous (neo-Darwinian) evolution and discontinuous (emergent) evolution.

Theistic continuous evolution represents the (still) accepted view of gradual large-scale evolution from matter to man. It includes the neo-Darwinian view of a gradual evolution of organisms. In its deistic form matter is viewed as created with the inherent potential to give rise to man. There is also a theistic form of this view in which the creative and providential acts of God are not distinguished, so that God is seen as creating continually up to now.

Theistic continuous evolution has the following implications for the moral nature of humankind. According to the theory of continuous evolution humankind inherited from animal ancestors not only the general structure of such things as the skeleton and the nervous system, but also various types of behaviour. This is not surprising since the structure and function of the nervous system is very closly connected with behaviour. We know that aggression, sexual promiscuity, infanticide and sexual behaviour with either sex (ambisexuality) are almost universal among animals.[1] These behaviours are assumed to have been present in animals also before man had evolved, otherwise man could not have inherited them. This means that these behaviours must have been part of God's good creation as it was before the appearance of man and, thus, before the fall. After the fall these behaviours were obviously still present and thus constitute a normal part of the moral behavioural repertoire of humankind today.

These implications for the moral nature of man do not agree with biblical revelation about man's original sinlessness, fall and need of redemption. The bible pictures Adam and Eve before their fall as images of their Creator. They were good, righteous and holy rather than sexually or parentally perverted. Moreover, it is not clear what the fall must have consisted of, if one believes that these behaviours typified man when he first arose from animal ancestors.[2] In addition, it becomes impossible to call these behaviours sinful in man, if it were true that they were not introduced with the fall, but belong to God's good creation. On this basis one can then question the need for the redemption of humankind. Finally, the more speculative evolutionary cosmologies[3] allow for spirituality to emerge only at the end of the evolutionary process, whereas Scripture reveals that spiritual man was created in the beginning.

These disagreements with the fundamentals of the Christian faith can be avoided by assuming a discontinuous view of evolution (emergent evolution). In it the creation of the categories of non-living, living and self-conscious beings is seen as being separated by great intervals in time. On this view, the creation of man by God would have consisted of creating a new being (man), differing from animals in that he possessed self-consciousness, but being animal-like in possessing all their structural, functional and behavioural characteristics. Man's original sinlessness would have been divinely ordained via spiritual constraints upon potentially sinful behaviours. The fall would involve the removal of these constraints, resulting in the actualization of the potential for sinful behaviour created by God in man.

1.2 Scientific Justification

Both the discontinuous and the continuous view of evolution are questionable because of the lack of evidence for processes crossing major cosmic boundaries as required for large-scale evolution.[4] These are the boundaries between material and living things, and between types of organisms (taxons) above the species-level. A recent assessment of reconstructions of molecular evolution as being in conflict with some of the fundamental laws of chemistry,[5] was approved by Dean Kenyon, a leader in the field. Moreover, there is a growing consensus among biologists that neo-Darwinean random mutation and natural selection are inadequate for crossing the genetic boundaries and driving large-scale evolution (see section 5.1.1).[6]

Strictly speaking the lack of evidence in itself is no evidence for the failure of neo-Darwinism. There is always the possibility of new discoveries. However, the lack of evidence for chemical and genetic mechanisms for evolution has now lasted for as long as the matter has been investigated. This situation justifies the pursuit of alternative interpretations of the past. This implies a reconstruction of the historical and some of the empirical segments of the natural sciences. In this paper, I will attempt to give a sketch of such a reconstruction. Since such interpretations necessarily occur within presuppositional frameworks, it will be illuminating to first analyze the impact of presuppositions in biology.

2. The Role of Presuppositions in Biology

2.1 Introduction

We first have to establish that large-scale evolution is not an objective fact, but a subjective interpretation of facts based on a communal acceptance of large-scale evolution as a hermeneutical framework for biology. The idea that theorizing is guided by worldviews was introduced by Dooyeweerd and his school.[7] In the modern philosophy of science observation was discovered to be theory-guided.[8] Case studies are beginning to show how worldviews have interacted with the practical and theoretical work of scientists. These developments are interesting because they may reveal the complex interactions between religious and metaphysical commitments and theories of various levels of generality and observations.

The following worldview-embedded presuppositions are important with respect to origin questions. The first two groups consist of presuppositions underlying scientific method and research programmes. Two more groups relate to the historical aspect of the study of organisms and to biological practise.

2.2 Some Presuppositions of Scientific Methodology

Two presuppositions in contemporary scientific methodology have relevance for the origins question. These are the principle of simplicity and the principle of uniformity.

2.2.1 Simplicity

Against unbridled speculation about the created things, William of Ockham (1284-1349) introduced the idea that, if there are several different explanations for the same phenomenon, the simplest one is true. This principle is called Ockham's razor. Ockham believed that the world is completely dependent upon God's will. Since God has not revealed His will regarding the natural behaviour of created things, Ockham felt that man has to find out himself by experience, not by theoretical speculation. Ockham's aversion towards speculation and desire for simplicity was religiously motivated. His view of the creation as contingent upon God's will was to function as a balance for a rationalistic approach to nature.

In contemporary scientific method this principle of simplicity no longer serves to eliminate unnecessary speculation. Rather, the simplest account of a phenomenon is an account that reduces this phenomenon to elementary particles and energy. The principle of simplicity has been replaced by the principle of reduction. There are different forms of the principle of reduction

Ontological reduction is the recognition that higher-level phenomena have a lower-level basis. For instance, physical and chemical interactions between atoms and molecules are a necessary, but not sufficient condition for cell metabolism, animal behaviour and mental phenomena. Ontological reductionism is the metaphysical view that lower-level phenomena not only are a necessary, but also a sufficient condition, for higher-level phenomena to occur.

Methodological reduction is a heuristic procedure seeking to explain higher-level phenomena in terms of lower-level phenomena. Based on ontological reduction, it refrains from attributing ontic reality to the hierarchical view of reality.

Theory reduction is an aspect of methodological reduction, emphasizing the derivation of higher-level theories from lower-level ones.

If the present cosmos arose out of elementary matter and energy in a historical process of evolution, theories about the former ought to be reducible to theories about the latter. This brings us to the place of historical research in biology, and its relation to the second presupposition, viz. the principle of uniformity.

2.2.2 The Uniformity Principle

Uniformity is an indispensible element in everyday life as well as in the sciences. There is uniformity in space. That is, the result of dropping a glass of wine will be the same in Toronto, Sydney or Amsterdam. There is also uniformity in time, meaning that the same thing would happen to a falling glass a million years in the past or in the future.

However, uniformity can be stretched beyond its limits. Recently, Howard Van Till has provided an example. He states:

> Because material properties are universal and because material behaviour, which is causally related to these properties, is coherent and invariable, the natural sciences can legitimately study cosmic history. Cosmic history is made up of a coherent sequence of causally related processes and events spanning several billion years.[9]

Elsewhere Van Till ponders the possibility of biological evolution.

> The more perplexing question, however, is whether or not the temporal sequence of life-forms revealed by the fossil record is the product of ordinary natural processes -- the same patterned behaviour of matter that leads inevitably to the temporal development of galaxies, stars, and planets. Various theories for the mechanism of biological evolution are currently being considered in attempts to answer that question. Personally, I see no reason, either scientific or theological, to preclude the possibility that the temporal development of life-forms follows from the properties and behavior of matter in a way that is similar to the processes that lead to the birth of planets, stars, and galaxies. I believe that the phenomenon of biological evolution, like any other material process, is the legitimate object of scientific investigation. The answer will be found by empirical study, not by philosophical or theological dictation. My guess is that a fully satisfactory description for the processes of biological evolution will eventually be worked out. I would be terribly surprised to discover that we live in a universe that is only partially coherent, a universe in which the temporal development of numerous material systems proceeds in a causally continuous manner while the history of other systems is punctuated by arbitrary discontinuous

> acts unrelated to the ordinary patterned behavior of matter (note carefully: I am not talking about the status of the cosmos; I am speaking only about the properties and behavior of the universe.)[10]

There is a theological and philosophical problem with this application of the uniformity principle. First, it excludes an instantaneous speaking into existence of a wide diverity of things by the Creator. There are sound arguments for the view that living things did not develop from non-living things,[5] but were created by God in great diversity. This means that the uniformity principle cannot be used across the boundary delimiting living and non-living. If you believe, as I do, that God created the major groups of plants, animals and man separately, then the implication is a drastic reduction of the extent to which the uniformity principle can be applied. This raises the question of the scope of the uniformity principle, which I will address below (see sections 4.2, 5.1.1., and 5.1.2.).

Secondly, Van Till ignores the limits of human experience. Suppose an investigator wants to test the hypothesis that all swans are white. In order to know with certainty that all swans are white he would have to be certain that he had seen all the swans in the world. However, it is impossible to be certain of this, if only because in his life-time he could not possible check every spot on earth. Therefore, the uniformity priniciple has to be accepted in good faith, and this is so because of the limitations of human experience. One can say that the uniformity principle arises out of experience, but cannot be justified by experience. Obviously, it is a reasonable principle, but only with an understanding of its limitations. A rationalistic understanding of the uniformity principle ignores these limits. In this form it is a worldview-guided attempt to exclude from the realm of natural science of uniqueness of historical events as well as the subjectivity of their interpretation, while reducing the study of history to natural science.

The uniformity principle is a belief required for empirical research to be carried out. This belief is carried over, however, in the reconstruction of human history as a process of evolution from matter to man. We see one religious commitment, in the disguise of neutral and objective experience, pitted against another, namely the belief in instantaneous creation. Therefore the choice is not between objective empirical science and the Bible, but between two kinds of religious knowledge. One divinely revealed and confirmed by the witness of the Holy Spirit, the other based on an overextension of human experience. This raises the question of the relation between faith knowledge and scientific knowledge, which will be taken up below (see section 4.1.). We first have to pursue one of the implications of the limitations of the uniformity principle, viz., the role of historical interpretation in biology.

2.2.3 Historical Interpretation in Biology

History unfolds, for instance, when an embryo develops from an egg or when a large group of organisms changes in time (study of fossils) or in different places (biogeography). Biology is, therefore, a combination of experimental study and historical reconstruction.

The general theory of evolution is such a reconstruction of the past. It is based on (a) documents of historical occurrences, such as fossils, volcanic eruptions etc., and (b) rules for the development of new species based on observation, experiment and theory. There are two aspects of biological history to be considered. One aspect is repeatable and uniform, the other is not. Obviously, everything that happens has repeatable and nonrepeatable aspects. This is the case, for instance, in the development of an animal embryo. In their study of embryonic development, biologists knowingly ignore the unique events, and focus on repeatable ones. Only then can an event be tested under different circumstances. It is this requirement of experimental testing that narrows the interest of the investigator to repeatable events that admit explanation. Explanation has to be replaced by historical reconstruction, for instance, in the case of most spontaneous abortions of human embryos. These are usually the result of some abnormality in the embryo. The possibility of explaining and preventing spontaneous abortions is very small, because most embryonic abnormalities are unique.

The study of spontaneous abortion is analogous to the study of the historical development of organisms, in more than one sense. The study of fossils is a study of a nonrepeatable succession of organisms characterized by many "abortions". The reconstruction employs unique fossils as well as knowledge of repeatable events involved in micro-evolution. Such historical reconstructions are always limited in two ways. Firstly, the known fossils form a very incomplete representation of the diversity of organisms once alive, because fossilization is a rare event, and selects only those organisms that are suitable for fossilization. Secondly, historical facts are used selectively in the reconstruction of history. And the selection is influenced considerably by the investigator's presuppostions about the history of the cosmos, which are usually evolutionary. Hence the predominance of evolutionary reconstructions in biology. However, this situation opens up the possibility for alternative reconstructions. The so-called empirical fact of evolution turns out to be much more determined by preconceived notions about the history of the world, than its proponents would like to believe. The crucial question in historical interpretation is, what can be accepted as historically given, and what requires explanation in terms of historical development. The historical givens I work with, are not elementary matter and energy, but a completely differentiated cosmos. That is, a cosmos containing the basic types of cosmic bodies, plants, animals and man, with a limited potential for change and development.

2.3. The Metaphysical Basis of Biological Practise

Worldview functions not only in scientific method, but also in the practise of everyday biology.

2.3.1. Probability Arguments

Creationists and evolutionists both use probability to argue the likelihood of, e.g. the spontaneous formation of the first protein molecule of e.g. 300 amino acids.

The probability argument against molecular evolution usually consists of calculations of the probability of the spontaneous development of a specified sequence of nucleotides or amino acids from a mixture of these. This problem is analogous to throwing 300 dice and calculating the probability of a specified sequence of numbers. Since each throw is independent of all others, $P=(1/6)^{300}$, a very small number.

The calculation is valid only, however, on the assumption that the specified sequence of numbers (amino acids) was created at once, each addition being statistically independent, and not via a gradual evolutionary process. This is where a prior belief about the origin of the cosmos determines how the statistical calculation is carried out. However, within an evolutionary framework, this assumption is invalid. Instead, a protein forms by subsequent additions of amino acids, with each additon possibly being chemically dependent on previous additons. In the die analogy the outcome of any throw would be determined by the outcome of previous throws. This means that one has to apply the base rule instead of the product rule of probability. The probability of each subsequent throw would be smaller than the previous one. As a result the probability for the spontaneous formation of a protein of 300 amino acids becomes higher.[11] Again a metaphysical commitment to evolution dictates the nature and outcome of the statistical calculation.

2.3.2. Comparative Biology

The differences in amino acid sequence of proteins,in the sequence of genes on chromosomes and in the physiological characteristics between morphologically very similar, but reproductively isolated (sibling) species of fruitfly are often much larger that between man and chimpanzee.[12] Since there is no difficulty in accepting the evolution of the one from the other species of Drosophila, there should be no difficulty regarding the evolution of contemporary apes and man from a common ancestor. However, the legitimacy of the comparison depends on one's worldview. Within a biblical worldview, man is not merely an animal. Therefore, a comparison of just the biological aspects of chimpanzee and man necessarily leads to great similarities by excluding uniquely human characteristics such as self-consciousness, morality, martyrdom, religion, etc. In other words, the conclusion is contained in the assumption.

2.4. The Metaphysical Basis of Research Programmes

Worldviews also dominate schools of thought in biology, and direct the development of research programmes. Worldviews suggest what kinds of questions are worth asking, and what kind of answers are acceptable.

The transition from idealistic to atomistic biology, in which Darwin played the major role,[13] is an example of the influence of worldview or metaphysical commitment of the choice of a research programme, and within the latter, on the choice of theories and experimental strategy. Idealism was the ruling paradigm in biology in Darwin's time. Organismic structure (Bauplan) was seen as an expression of God's eternal ideas (archetypes). This implied a static view of organisms and a research programme focused on structural constancy rather than indefinite variation in organisms. (In addition, mainline Christian theology of that time had absorbed Platonic idealism into its "theology of Creation", and this came to expression amongst others in the idea of the fixity of the species.) Various factors led to a transition from idealism to atomism. Within the atomistic worldview attention was much more focused on variability than on structural constancy. From this developed population biology, which has been heavily criticized for failing to ask how variations in gene frequencies are possible within the structural constraints of the organism.[14] Interestingly, the only subdiscipline unaffected by this transition was embryology. Embryologists adhere to a much more static view of the organism, due to the sensitivity to minor disturbance of embryonic development. Only recently have the two subdisciplines started to communicate and to recognize the paradox within evolutionary theory. As a result neo-Darwinistic evolutionary theory is being reconsidered at a fundamental level and a new and vigorous area of research has emerged. My point is that different worldviews implied different views of organism, which in turn led to different research programmes, results and interpretations. Interestingly, biology eventually appears to be self-corrective, based on empirical considerations.

2.5. Conclusion

Having established a role for metaphysical commitments in (biological) science, an important question remains. Do metaphysical commitments destroy the alleged objectivity of the natural sciences or is their directing force subject to certain rules. To address this question I will now discuss the hierarchical view of the cosmos.

3. A Hierarchical Frame for Theorizing

3.1. What is a Hierarchy

Our cosmos consists of things and processes. On the basis of their properties one can rank things and processes according to various criteria, such as size, speed or temperature. I propose to rank properties according to whether or not they are necessary for other properties to exist. Let us take, for example, a property of matter such as shape, and a property of organisms such as reproduction. Shape (enzymes) or extension (stereochemisty of DNA) are necessary conditions for reproduction to occur, but not vice versa. Therefore, physical properties are more basic than organic properties and are ranked lower. One can repeat this with properties other than physical and organic. The more levels of properties are stacked on top of each other, the highter the complexity at the top level. Therefore, this is also a ranking according to the level of complexity. One can also rank things and theories about things according to their highest level of complexity. This yields a hierarchical ranking with interesting properties for questions about faith and science in general, and about creation and evolution in particular. Let us look at three examples of such hierarchies.

3.1.1. A Page of Printed Text

On a page of printed text one can distinguish between two levels of complexity, viz., its physical basis (paper, ink, etc.) and its meaning.[15] The matter of interest, obviously, is the meaning of the words made of strings of symbols. This meaning cannot be derived from the physical basis. The meaning was contributed by the author, by constraining ink molecules into the shape of symbols and words into sequences according to grammatical rules. This example illustrates two properties of a hierarchy, viz., generality (or repetition) and constraint (or uniqueness). <u>The principle of generality or repetition</u> indicated that all material things have physical attributes and that these are subject to physical laws. The laws of chemical bonding governing the attachment of ink to paper, also hold for chemical bonding inside cells, for instance. <u>The principle of constraint or uniqueness</u> implies that there are only some things in this world that are merely physical, such as rocks, clouds and ink. Ink molecules have the potential to be formed into many other non-physical things, such as a written text or an illustration for a book. This occurs by placing constraints upon the ink molecules so as to make letters, or constraints upon sequences of letters so as to make words, or constraints upon word sequences so as to make sentences, etc.

3.1.2. <u>A Cell</u>

Let us take cells as a second example of a hierarchical system. Cells are also characterized by at least two levels of complexity, viz., the physical level of molecules and the cellular level of assimilation, reproduction and other attributes unique to cells. A simple example would be the temperature-dependency of chemical and biological catalysts. Whereas with a non-enzymatic catalyst the reaction rate increases exponentially with the increase of temperature, for an enzyme the rate increase will level off at the optimum temperature. The plateau and the subsequent decline of the reaction rate reflect cellular constraints upon the relation between tempertaure and reaction rate. These constraints derive from the uniquely biological properties of an enzyme, such as its amino acid sequence and shape which cannot be derived from the physical law that relates temperature and reaction rate. Again we see the principle of generality, in that the laws for chemical reactions apply both at the molecular and at the cellular level. The principle of constraint is revealed in that biological constraints are placed upon the temperature range (scope) within which the physical relation between temperature and reaction rate is valid.

3.1.3. An Organism

An organism is our final example of a hierarchical system. Charles Darwin introduced an atomistic view of organism. The properties of organisms were conceived to be in continuous flux and to display no structural relationships to each other. A clear expression of this metaphysical commitment is found in population biology, where one has lost sight of the structural constancy of organisms.[16] As the atomistic view of organism was elaborated in the Darwinian and neo-Darwinian theories of evolution, the structural view of organism prevailed in embryology. Within this latter view there was little room for large mutations, because they were observed to disturb delicate structural and homeostatic balances.. Thus we see that at the level of the organism, structure places constraints upon the viability of mutations, which occur at the molecular level according to physical laws (priniciple of generality). In other words, not only the environment external to an organism, but also its internal environment as represented by its structure and function, selects from mutations. Since the structure of organisms is hierarchical, the hierarchical or structural view of organism introduces a degree of structural constancy, while maintaining room for change within limits.

3.2. Hierarchical Relations Between Theories

If things can be classified hierarchically on the basis of their attributes, so can theories about them. That is, lower-level theories are still valid within higher-level theories. However, the higher-level theories limit the scope of lower-level theories by their boundary conditions. These boundary conditions are part of the higher-level theory. For instance, to account for enzyme function, the theory of protein structure refers to the temperature-sensitivity of the chemical bonds that generate and maintain the enzyme's three dimensional structure. This temperature-sensitivity is a boundary condition for the relation between reaction rate and temperature in enzymatic reactions. Thus the higher-level theory limits the range of temperatures over which the lower-level theory is valid.

There is a second relation between theories at different levels, viz. the relation of exclusion. Suppose a number of different theories were available to explain the relation between temperature and reaction rate. Given the higher-level boundary conditions, it appears that a given theory does not account for the observations. The theory then has to be rejected. An example of exclusion is provided by the theory of molecular evolution applied to nucleic acids and proteins. In a cell, the replication of nucleic acids depends on cellular-level boundary conditions, such as the presence of enzymes, ATP and a nucleic acid template. Given the necessity of these boundary conditions, the claim of the theory of molecular evolution that nucleic acids and proteins could have arisen spontaniously, i.e. without those boundary conditions, has to be rejected. The crucial question in origins research is, therefore, shifting from the mechanism of evolution to the origin of the boundary conditions. The two opposing claims are, that boundary conditions either have emerged spontaneously in the course of time, or are given in the same sense that gravity is a given. The latter claim is consistent with the view that boundary conditions were created. Thus the two relations between theories, that are relevant for our topic are that lower-level theories can be limited in scope or excluded by higher-level theories. In other words, a higher-level theory can determine the scope and the choice of lower-level theories.

4. How does the Hierarchical View Contribute to a Christian Understanding of the Relation between Faith and Science?

My proposal is to view the relation between theological knowledge and biological or historical knowledge as a hierarchical relation. The hierarchical view of the cosmos provides a general framework for relating theological, metaphysical, and scientific knowledge.

4.1. The Complementary Nature of Explanation

The classical example was introduced by Polanyi and deals with the boundary between molecules and cells. He stated that:

> As the arrangement of a printed page is extraneous to the chemistry of the printed page, so is the base sequence in a DNA molecule extaneous to the chemical forces at work in the DNA molecule.[17]

Polanyi likens a DNA molecule to a machine. He states:

> The machine as a whole works under the control of two distinct principles. The higher one is the principle of the machine's design, and this harnesses the lower one, which consists in the physical chemical processes on which the machine relies.[18]

The principle of design according to which the machine was constructed represent the boundary conditions, that constrain the workings of its parts for the purpose set by the designer. Within the machine the laws of physics and chemistry remain valid, but their "action" is constrained by the boundary conditions. Polanyi goes on to compare organisms with machines.

> ...the organism is shown to be like a machine, a system which works according to two different principles: its structure serves as a boundary condition harnessing the physical chemical processes by which its organs perform their functions.[19]

He argues that a boundary condition is always extraneous to the process which it delimits.[19] This is another way of saying, that the boundary conditions cannot be reduced methodologically to the processes delimited by them. He seems to argue that boundary conditions have to be understood as historical accidents, that are not amenable to scientific investigation, but only to historical reconstruction.[20] Applied to DNA this means that:

> The pattern of organic bases in DNA which functions as a genetic code is a boundary condition irreducible to physics and chemistry.[21]

A reductionistic account of the DNA molecules would consist of a <u>bottom-up explanation</u> in terms of the chemical-physical dynamics of the DNA molecule covered by physical laws. A complete account would add to the former a <u>top-down explanation</u> in terms of the constraints placed by boundary conditions on the chemical-physical dynamics of DNA replication. That is, the base sequence of the template constrains the number of possible base combinations in the daughter strand to the actual complementary sequence. The system is driven away from equilibrium (random base sequence) to a specified complex base sequence.

Stated generally, the explanation of irreducible phenomena would have to consist of at least two accounts. Firstly, one needs an account in terms of the lawful behaviour of the lower-level subsystems. This corresponds to methodological reduction, and is a simple recognition of the fact that higher-level systems are composed of lower-level subsystems whose lawful behaviour is not eliminated at higher levels. The study of subsystem behaviour corresponds to the study of mechanisms and is the work of empirical biology. In addition one needs an account in terms of the constraints placed upon subsystem behaviour by the boundary conditions. The boundary conditions drive the subsystems away from their dynamic equilibrium. As a result the system properties cannot be derived from the properties of the subsystems in isolation. The boundary conditions have to be considered as historical givens. They would require a historical rather that a scientific explanation.

Thus, instead of explanation as methodological reduction we should pursue complementary explanation. That is, explanation both from the bottom up and from the top down. Perhaps pluralistic or multilevel-explanation is a better term than complementary explanation, because the explanation of any subsystem may require taking into account more than one lower-and higher level of organization.

Let us now look at whether theological and biological knowledge can be complementary. As an example we will take the relation between the doctrine of creation and the theory of evolution, the latter apart from its manifestation as a worldview. In the introduction I presented theological and scientific arguments for my rejection of large-scale evolution from matter to man. For the Christian the theological doctrines of creation, fall and redemption can be taken as the boundaries within which biological theorizing ought to occur. There are then two options regarding the theory of evolution, viz., to limit its scope or to reject it altogether. One can limit its scope by not including human origins. It is entirely possible that God created man instantaneously, but brought forth the remainder of the cosmos via gradual, emergent evolution. I reject this option mainly because a theory of evolution of only animals and plants still faces the lack of mechanisms to cross major discontinuities such as those between nonliving and living things as well as between taxons above the species level. My choice then is for excluding the theory of large-scale evolution. A similar line of argument can be set up for the relation between, for instance, the doctrine of creation and the theory of the historical development of religion.

The most common objection to this procedure is,that faith or theology dictate the internal affairs of the natural sciences. This would introduce an uncontrollable degree of personal bias into the objective natural sciences. However, the newer philosophy and history of science have revealed that a diversity of subjective factors is normally at work also in experimental science. Objectivity is now undertood by many to be the agreement about methods, observations and theories within a community of scholars who share a given world picture or worldview.[22] Pure objectivity has been recognized as an illusion. Without adopting the extreme relativism inferred by some on this basis, this situation justifies the development of a biblical view of the cosmos and in particular of its history.

The second objection against theological imperialism in science is that theological knowledge cannot be revised, because some believe that it has absolute certainty. This objection is based on a failure to properly distinguish among three distinct types of knowledge: faith knowledge, theological knowledge and scientific knowledge. Faith knowledge is characterized by trust, certainty and commitment of the whole person to God the Father, the Son and the Holy Spirit. It is a sure knowledge and heartfelt conviction concerning the fundamentals of the Christian faith as revealed in the Scriptures and expressed by believers in various creeds. It is not open to fundamental revision, but only to correction and growth, based on the standard of the Scriptures. Theological knowledge, however, has a rational dimension. It can be and has been modified to accomodate new insights from astronomy, biology, semitics, and archeology.

For instance, theologians once insisted that the earth must be in the centre of the universe, but now all accept that the sun is the centre of our planetary system. This is because it has been recognized that the Bible is indifferent with respect to whether the earth or the sun is in the centre of the universe, as long as the central position of man in the creation is not confused with the geographical position of the earth in our planetary system. Galileo's problems with the church were partly caused by the fact that theologians had confused man's status as the crown of creation with the physical centrality of the planet on which he was placed. Likewise, theologians once believed that plant and animals had been created not only with the exact characteristics as we know them today, but also in the same geographical locations. This was inferred from the belief that each organism had been created in order to fulfill a specific purpose. We now accept that the Bible is indifferent with respect to whether biological species of plants and animals are fixed or can change, as long as this does not contradict what the Scriptures reveal regarding the origin, nature and purpose of man. Some believe that the Bible is also indifferent regarding a presumed animal ancestry of man, because such ancestry need not be in conflict with God's revelation concerning man's initial sinlessness, his fall and need for redemption. My point has been that here we have a real conflict between faith knowledge and theological knowledge on the one hand and scientific knowledge on the other.

These and other problems can, I believe, best be approached with a hierarchical relationship between faith knowledge on the one hand and theological knowledge and scientific knowledge on the other. This simply means that Christian biologists are free to invent any hypothesis about organisms and their history, as long as these remain within the bounds of faith knowledge (and theological knowledge inasmuch as the two overlap). I know full well that this is the ultimate heresy to many natural scientists. However, consider that my suggestion does not mean a return to the medieval situation, in which all aspects of life, including academic life, were determined by the ecclesiastical hierarchy. Instead, in my hierarchic relation, faith does not prescribe what scientists ought to consider, but it provides boundaries for natural science. In as much as scientific theories have implications outside of these boundaries, the scientific theories ought to be changed to respect faith. This leaves academic freedom intact as freedom to serve the Lord within the bounds of His revealed will, and removes the aspect of the autonomy of human reason. Of course, faith knowledge has its own boundary in the Word of God. And the latter provides its own boundaries.

4.2. The Prinicple of Discontinuous Uniformity

The hierarchical view also provided a concept of uniformity that (1) does not exclude instantaneous creation and (2) is perfectly consitent with the empirical sciences.

Uniformity in The Fourth Day means physical continuity across the board, except for the origination of elementary matter and energy. However, physical continuity does not exclude discontinuities. In fact, experimental science suggests the existence of such discontinuities at least at two crucial junctions in the assumed progression of large-scale evolution. One is at the transition from non-living matter to living organisms.[4] The other is a discontinuity between types of organisms, consisting of a structural and genetic barrier to natural and artificial selection.[23] Uniformity, I suggest, does not apply across the board, that is, across physical, biological, psychological, etc. entities. Rather, there are different kinds of uniformity. There is physical uniformity that extends to all physical entities and to all non-physical entities only insofar as they behave as physical entities. Likewise, there is biological uniformity that extends to all biological entities, and to all non-biological entities insofar as they behave as organisms (e.g. man), except physical entities, and so on to psychological uniformity, etc. In other words, physical uniformity extends across the physical side of things, biological uniformity extends across the biological side of things, etc.

5. How does the Hierarchical View Contribute to Biological Theorizing within the Bounds of Scripture?

The Hierarchical view may contribute to biological research by providing a better account of observations and experiments, and by suggesting new research and alternative explanations.

5.1. Better Accounts

5.1.1. Towards a Post-neo-Darwinian Biology

Part of the current controversy about mechanism of neo-Darwinian evolution is about whether large-scale evolution is caused by the gradual accumulation of small mutations or by occasional drastic changes of body design (macromutations). Is the mutation and selection of genes such as those that control protein content in corn, the number of bristles on an insect's body segment, the size of beans or the resistance against pesticides and antibiotics relevant for large-scale evolution? Biologists are beginning to realize that they have been looking at the wrong genes for an understanding of the large-scale changes in body design that are required by large-scale evolution.

The overall structure of an organism's body arises during embryonic development. Except for comparative embryology, developmental considerations have not been part of phylogenetic theories up to now. However, an understanding of large-scale evolution will come only from an understanding of how body design arises during development. The latter has not yet been achieved. We do know, however, some of the genes that disturb normal body design.[24] Mutations in these genes have been either lethal, or revert back to normal in the absence of artificial selection. A hierarchic model provides a better account of this situation than the neo-Darwinian model. In the hierarchic model, overall body structure and homeostasis provide the boundary conditions within which mutational change can occur. The great majority of mutation are in this category of genetic change within boundaries. They are part of a mechanism for adaptation to environmental change. The boundaries, however, limit the extent of change the species can absorb. Therefore, the hierarchic model also accounts better for the predominance of extinction due to drastic environmental change beyond the boundaries for adaptation.

5.1.2. Experimental Self-Organization

Given that boundary conditions limit the genetic variability of organisms, it is not surprising that contemporary research focuses on how new boundary conditions can arise. It is claimed that processes of self-organization can produce new boundary conditions.[25] For instance, viruses, cell organelles such as ribosomes and microtubules and tissue cells, either embryonic or differentiated, have the ability to reorganize themselves spontaneously after having been separated into parts. Dissociated mouse cerebellar cells spontaneously restore the layered structure of the cerebellum in a rotating culture.[26] If this is an example of self-organization, then the restoration of the stratification should be explainable in terms of the properties of its constituting cells. This is problematic, however. A fundamental phenomenon in developing embryos is that the properties of a differentiated cell depend on its position in the embryo. Thus the properties that enable the cerebellar cells to spontaneously stratify have been acquired as a function of their position in the embryo. This renders the property that enables the cells to stratify an organism-level property. Consequently, one cannot argue that the properties of tissue structure can be explained in terms of the properties of its constituting cells, because the latter are organism-level properties.

The same argument can be made for cell organelles. The properties of their parts, the protein subunits, have been acquired in the context of a cell. This context includes the genetic information for the protein subunits as well as for the metabolic "machinery" required to produce the subunits.

It is possible to determine which properties are genuine parts properties, and which ones depend on the context of the parts, i.e. are determined by the over-all system. For instance, in the case of differentiation attributes of cells, one can change the position of the cell within the embryo by transplantation. If this is done early enough, one will discover that "household" metabolic attributes remain unchanged, but that biochemical differentiation pathways have switched to conform to the new location of the cell. Thus "household" metabolic functions are independent of the context of the embryo. The same transplantation done later in development may result in the transplanted cell differentiating according to its original location. This illustrates that context-dependent attributes can become context-independent. Similar results are seen upon explantation of an embryonic cell. The isolated cell either gives rise to a complete embryo (embryonic regulation) or to one of its parts (mosaic development). Thus, early in a cell's life metabolic household functions are genuine cell properties, whereas biochemical differentiation pathways are organism-level properties. The latter are transferred to the individual cells in the course of development.

Similarly, one can apply the criterion of context-independence to the cell and its parts, such as organelles and metabolic pathways. Obviously, all inorganic cell constituents, such as water, ions, acids and bases are context-independent. Their properties do not change inside or outside of the cell. Likewise, the properties of simple organic molecules, such as amino acids or nucleotides are the same inside and outside of a cell. Their origin is not cell-dependent, i.e., they can be generated spontaneously outside cells.[27] However, the situation is different for larger organic molecules, such a proteins, lipids and nucleic acids. The existence of such molecules depends on the presence of self-replicating nucleic acids, and these are found only in cells. A spontaneous development of nucleic acids has been postulated[28], but is considered speculative and in conflict with the laws of equilibrium chemistry.[29] The conclusion is, that entities that appear to be self-organizing processes cannot be accounted for. It appears that higher-level properties do not arise spontaneously.

5.1.3. Comparative Biology

One of the paradoxes in contemporary comparative biology is that two given organisms, for instance, man and chimpanzee are very similar at the molecular level, but very different at the organismal or higher levels.[12] This paradox can probably best be introduced by an analogy. Imagine someone wants to express the difference between Paley's Natural Theology and Darwin's Origin of Species by comparing letter frequencies. The letter frequencies turn out to be the same, whereas the meaning of the two works is rather different. It is this meaning that is lost in such an analysis.

The same problem arises when the similarity or phylogenetic distance between two organisms is expressed in molecular terms. For instance, the genetic difference between species can be expressed as the number of positions in a protein molecule, such as cytochrome c, that are occupied by different amino acids.[30] The resulting trend is that the wider apart two species are taxonomically (morphologically), the greater the number of different amino acids. The problem is that amino acid analysis results in more similarity that is morphologically justified. For instance, on average the amino acid composition of a human protein is about 99% identical with the equivalent protein of a chimpanzee, but their phenotypic similarity is somewhat less obvious.

I suggest that the disparity between molecular and morphological similarity results from what some have called "the organism is DNA syndrome." To compare organisms at one of the lowest levels of organization only means to assume that structure and function at higher levels can be reduced to the molecular level. However, if this were the case one would expect molecular and morphological comparison to yield similar phylogenetic distances. What are lost in this reduction are the control hierarchies of genes, cells and tissues whose interactions during development generate characteristics that cannot be reduced to the absolute amount of DNA, or to frequencies of amino acids or nucleotides. Such control hierarchies are probably very important in establishing body design and phenotype during embyogenesis, but are presently poorly understood.

I suggest that the fundamental problem here is to decide what should be considered in the comparison of two species. A comparison of just the organic aspects chimpanzee and man necessarily leads to great similarity because it excludes from the comparison such uniquely human characteristics as self-consciousness, morality, martyrdom and religion. In other words, the conclusion is contained in the assumption. Ideological reductionists consider the DNA to adequately represent the organism. Thus their metaphysical commitment dictates what enters the comparison. Thinking hierarchically, one considers higher levels such as the morphology of an organism or human self-consciousness and religiosity to have at least the same weight as lower levels. This metaphysical commitment allows one to take a greater part of reality into consideration, and to develop a more complete account of it. Thus in the hierarchical account, common descent is not a necessary condition for similarity. Rather, similarity is a property of the hierarchical structure of the cosmos. Since I work with the assumption that the basic structure of creation is hierarchical, similarity must be accounted for theologically by common design, rather than historically by common descent.

5.2. A New Hypothesis Regarding the Lack of Correlation between the Amount of DNA and the Complexity of an Organism

> Measurements of DNA in different organisms have revealed that, perhaps as expected, eukaryotic genomes consist of much more DNA than prokaryotic or viral genomes. Although, for the most part, higher eukaryotes contrain more DNA than lower eukaryotes, there is considerable variation in the amounts of DNA even among similar species. Certain less complex species have significantly more DNA

> than other species higher on the evolutionary scale; in fact amphibians and lillies usually have the highest DNA content per cell of any organism. The lack of correlation between the amount of DNA and complexity of an organism is puzzling[31].

This lack of correlation may be resolved by assuming that the complexity of DNA function, i.e. to the complexity of hierarchies of genetic control which, during embryonic development, produce phenotypic complexity. Thus hierarchy theory suggests that there be a correlation between phenotypic complexity and the complexity of genetic control hierarchies rather than the absolute amount of DNA. To test this, one should conduct a comparative study of the complexity of genetic control hierarchies in organisms with widely different phenotypic complexities. I am ignoring here the problems involved in defining and calculating such complexities. The point of the example is, that the irreducibility of phenotypic complexity to the absolute amount of DNA per cell may be resolved by assuming that there are levels of organization of DNA above the double helix, which control gene expression and the development of phenotypic complexity.

6. Summary and Conclusions

6.1 The technical concerns of the natural sciences are to be distinguished from cosmological and worldview questions.They cannot be separated from each other, especially when scientific theories have worldview implications. Since the theory of large-scale evolution has worldview implications, especially regarding human origins, it cannot be separated from the worldview of evolutionism.

6.2 There are fundamental theological and scientific objections against neo-darwinism as a theory of large-scale evolution.

6.3 The nature of the theological problems is so fundamental that a reconstruction of cosmic history is necessary.

6.4 To prevent such conflicts between different kinds of knowledge, I propose a hierarchical model for the relations between levels of knowledge. There may also be nonhierarchic relations.

6.5 Within this model there are relations between theoretical knowledge at different levels. A higher-level theory can either limit the scope of, or exclude a lower-level theory. These relations constitute a link between religious and metatheoretical commitments, theories and observations.

6.6 These relations provide guidelines for the reconstruction of segments of a field of knowledge.

6.7 The hierarchy model fosters academic freedom, interpreted as freedom to serve God and His people. That is freedom from false myths, rather than freedom from any constraints on theorizing and observation. A phenomenon at any given level can always be explained by an unlimited number of theories that fall within the boundaries of the higher-level theory. Moreoever, higher-level boundaries are subject to correction.

6.8 In the hierarchy model the natural sciences remain self-correcting. The flux of scientific knowledge does not require constant revisions of theological knowledge. Occasionally, scientific knowledge can necessitate theological revisions, but these occur within the boundary conditions provided for theology by the Scriptures.

6.9 In the hierarchy model the crucial question for origins research is how to distinguish between boundary conditions created in the beginning and those devloped in time, i.e. historically given. This question can be answered at least in part empirically. A putative transition from non-living to living contradicts well-established laws of equilibrium and polymer chemistry. Putative transitions between genetic units above species-level is in conflict with the structural and functional stability required for an organism's survival and reproduction.

6.10 The contemporary materialistic-reductionistic worldview guides most of the natural sciences. Reductionism denies the reality of higher-level phenomena. As a result it produces incomplete knowledge. The uniformity principle excludes research into the existence of fundamental discontinuities in the cosmos. Atomistic evolutionism excludes research into the stable properties of organisms.

6.11 The hierarchy model is new and does not yet have a scientific track record. It promotes a multidimensional view of reality that does not exclude certain phenomena from scientific research. Uniformity is multidimensional in that it does not apply across qualitatively different aspects of reality. It suggests a structural-hierarchical view of organisms. This accounts better for the observed limits to genetic variablity and to processes of self-organization. The hierarchical approach also provides criteria for the legitimacy of comparisons in comparative biology. Finally, it suggests research into hierarchical control mechanisms relating the information on the DNA to the phenotype of the developing organism.

Notes

1. For instance, "cows in heat so frequently mount other cows that the behaviour is considered diagnostic of the estrous condition": Denniston, p. 34.

2. The consequence is a collapse of the creation and fall of man. Either man was created as a fallen being and was aware of this fact. Or, if he was not aware of it, the fall is seen as the end of a period of innocence rather than sinlessness and as a becoming aware of his sinful nature. The period of innocence is pre-human because it implies that man was not fully selfconscious. An example of this view can be found in John Baker, Expository Times <u>92</u>, 235-237 (1981):

   'Before the entry of the serpent there is a harmonious relationship between Adam and Eve and God. In the calm and plenty of the Garden no question of need or doubt arises. Most important of all, Adam and Eve are in a state of absolute acceptance, of innocence, and the <u>possibility of choice</u> has never arisen. <u>What the serpent achieves is to pose an alternative to innocence, to introduce the posibility of choice</u>. The theological doctrine of the Fall argues that the serpent's (i.e., Satan's) aim was to alienate man from God. Within the setting of the myth, however, all that it could do was to offer an alternative to innocence, without necessarily causing a rift between man and God. On this basis the story of Adam and Eve takes on different significance. What happens there is not a "Fall", but an <u>awakening</u>, and the so-called "alienation" or separation of man and God is really a form of freedom, necessary to man's full development. Man should have knowledge and choice and power, if he is to be fully man. When looked at without the bias of later theology, the myth is seen to be the story of man's inevitable spiritual development, out of dependence, out of innocence and total security, into the world of reality and moral choice. It describes the loss of one kind of harmony - a childlike identity with God - but what it does not point out is the possibility of another kind of harmony between man and God, based not on an unconscious innocence, and identity of man with God (similar to that of animals with nature), but a harmony arising from choice, i.e., the adult, self-conscious man choosing without compulsion the will of God in perfect freedom, and doing this even in the face of temptation and stress. Thus the story of the Garden portrays, not man's Fall, but man's liberation, his entry into full adulthood, possessed not of unconscious goodness and incorruptible innocence, but of the power of choice - i.e., "the knowledge of good and evil" ...What of the later Christian doctrine of the "Fall"? This was based on man's "disobedience" of God's command, but with a complete lack of understanding on the part of the early theologians of the nature of that disobedience.

They did not consider the alternative - the state of innocence, or else they were so enamoured of that alternative that they failed to understand its true nature. The myth really concerns man's choice of free-will, as opposed to the blissful innocence of the un-free robot... In those conditions, the choice of freedom cannot be called "sin", nor can the resultant state be called a "Fall". The true story of man'[s Fall could, for a theologian determined to find it in the Bible record, only begin with the sin of Cain, who exercised his power to do an evil deed.' (pp. 236-7).

3. For example: De Chardin, T.

4. There are more components to the contemporary critique of neo-Darwinian evolution. See e.g.: Denton, Eldredge, Goodwin, Gould and Lewontin, Grasse, Ho and Saunders, Lovtrup, Pollard, Thaxton _et al_.

5. Thaxton _et al_., 1984.

6. E.g. Goodwin, Ho and Saunders, Lester and Bohlin.

7. For introductions see: Wolters, Kalsbeek.

8. E.g. Brown.

9. Van Till, p.118.

10. ibid., p.188.

11. Creation would involve the simultaneous assembly of, for instance, 300 amino acids(A) from a set of 20 different types, with the probability of each addition, p(A), being independent of the probability of other additions. If p(A) = 1/20, then P_c (A_1, ..., A_{300}) is $(1/20)^{300}$. Evolution involves the sequential assembly of the same protein. But now the probability of a given addition depends on all previous additions, for instance, for stereochemical reasons. This situation requires use of the base rule:

    P_e (A_1, ...A_{300}) = P_1 (A_1) P_2(A_2/A_2) P_3 (A_3/A_2 A_1).

    P_4 (A_4/A_3 A_2 A_1) --- P_{300} (A_{300}/A_{299} ----A_1).

    Since P_n + 1 P_n, (n = 1, ..., 300), therefore

    P_e (A_1...A_{300}) P_c (A_1 ...A_{300}).

12. Grant, pp.284-286.

13. Lewontin, pp.4-5.

14. Gould and Lewontin, p.594.

15. Polanyi, p.233.

16. Gould and Lewontin, p.597.

17. Polanyi, p.229.

18. ibid., p.225.

19. ibid., p.227.

20. ibid., p.234.

21. ibid., p.239.

22. E.g. Toulmin, pp.252-253, Brown, p.154.

23. Lester and Bohlin, Ch. 8.

24. Raff and Kaufman (1983).

25. Salthe, pp.155-160.

26. Delong and Sidman, 1970.

27. Miller and Orgel, 1974.

28. Eigen and Schuster, 1979.

29. Thaxton _et_ _al_., pp.129-131, 151-154.

30. Curtis pp.380-385.

31. Suzuki _et_ _al_., p.416.

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