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Practical theological research into education and evolution in South African High Schools – teaching learners to think!

ABSTRACT

The author examines the problems and opportunities provided by the recent introduction of the teaching of the neo-Darwinian theory of evolution into the South African secondary education curriculum from a practical theological perspective. The Darwinian theory is described and the pros and cons of the evidence that supports it discussed. The various Christian attitudes towards neo-Darwinian evolution are used as a springboard to provide suggestions to aid educators teach what the curriculum demands whilst remaining within the parameters of their interpretation of the Genesis account and at the same time enabling learners to think intelligently about the faith and science in modern society.

1. INTRODUCTION

In 2006, the South African Ministry of Education introduced the teaching of Darwinian evolution it into the Life Sciences Curriculum for grades 10 to 12 (Holtman 2010:102,103).

The author has examined Life Science textbooks (grade 10, 11 and 12 textbooks authored by Buckley et al. (2005), Clitheroe et al. (2006), and Grogan & Suter 2010 respectively) and a grade 10 worksheet (Sterrenberg & Fouche nd.). The grade 12 textbook is the prime focus of attention for this article since its 97 pages cover evolution in excellent, very comprehensive and, usually, up-to-date detail (4.1.1 to 6.6.2.).

I examine the challenges and opportunities this presents, since practical theology is concerned with every activity covered by the kingdom of God and every idea and action that will extend the visible influence of the kingdom of God into the public sphere (Osmer 2008:x). The Kingdom, not the church, is the starting point for a practical theological study (Meeks 1979:67). Practical theological is therefore, of necessity, multi-disciplinary and interacts with other disciplines such as the social sciences, the arts, science, mathematics and/or philosophy. The object of this inter-action is not that the practitioner achieves expert status in the relevant disciplines, but the practical wisdom to act faithfully and effectively in the real world by accessing what experts know.

In this study I interact with, or touch upon, trinitarian natural theology, Old Testament hermeneutics, education, the philosophy of science, ethics, geology, paleontology, and molecular biology with the humble hope that I, as someone with a life-science background but not a specialist in most of these areas, am interpreting their discoveries and theories acceptably and making reasonable suggestions for a theological-scientific intervention in the classroom. The purpose of this intervention is to teach Christian learners to think from a Christian perspective about they are being taught that will help them engage productively with the modern world.

2. THE CHALLENGES PRESENTED BY THE TEACHING OF DARWINIAN EVOLUTION

With the increasing loss of confidence in the previously predominant Christian meta-narrative in South Africa, the teaching of Darwinian evolution presents the church and society with new

dangers and opportunities. The dangers involve a potential loss of faith in the Judeo-Christian revelation, the resultant moral consequences for society of this, and offending the consciences of educators and learners who reject the theory of evolution for religious reasons.

Research carried by the Church of Scotland in 1995 seems to confirm Dawkins' (1986:6) statement that "Darwin made it possible to be an intellectually fulfilled atheist". It discovered that one of the main reasons why people no longer believe in Christianity was because evolutionary theory offered a satisfactory alternative explanation of how we came to be here to that of Christianity (Bruce 2006:646). This move to a "practical" or "professing" atheism is dangerous since as Dostoevsky (1880, 1990:589) pointed out, "If God does not exist then everything is permissible".

This means that the teaching of Darwinian evolution may have long-term moral consequences since as a scientific theory it offers no basis for standards of moral conduct. It therefore can be used to support any ethical preference (Behe 2000:28). For instance Spencer misapplied the "survival of the fittest" concept to develop "Social Darwinism" (Lever 2002:21,22, Lennox 2009:103). Statements such as "At some future period... the civilized races of man will almost certainly exterminate and replace the savage races throughout the world" (Darwin (1874:178) may have influenced him. Thus Darwinism indirectly underpinned the theory of eugenics, with its "repugnant racial theories" (Pandor 2002:63) as well as fostering creeds of international competitiveness and national survivalism (Bobbitt 2003:201).

The third danger is that many educators are being compelled to teach Darwinism who are ignorant of it and/or do not believe in it. Not only do the majority of Life Science teachers lack the most fundamental knowledge concerning evolutionary theory but they also regard it as a personal attack on their religious beliefs (Holtman 2010:105,106). They are in effect being forced to do something that offends their conscience. One teacher sums up her rejection of evolution as follows:

Large-scale evolution is fictitious for me; there really is no proof, there are gaps in the fossil record. There is no solid evidence for me that things come from other things. The bible is the justification for origins as it goes step by step. I understand their (evolutionists') argument, but I do not believe it (Holtman 2010:106).

These dangers cannot be avoided by the banning of the teaching of evolution since there are compelling reasons for teaching the theory. The theory is so pervasive in modern science and medicine that it cannot be ignored (Wilmot & Wilson 2002:3). It is a unifying framework within which many diverse biological facts are integrated and explained. Scientific literacy cannot be achieved without understanding it (Holtman 2010:102) for as Dobzhansky (1973:449), a committed Christian, declared, "Nothing in biology makes sense except in the light of evolution". Lastly, "Its introduction into the school curriculum provides children with access to ways of thinking that can make them more enlightened citizens" (Dempster & Hugo 2006:106).

3. WHAT IS THE THEORY OF DARWINIAN EVOLUTION?

Evolution may be used with various meanings. It may be primarily understood as any change, development or variation. "When people speak of the evolution of life in this sense, all they mean is that life arose and has developed (by whatever means). Used in this way, the term "evolution" is neutral, innocuous and uncontroversial" (Lennox 2009:101ff).

This article is concerned with the Darwinian theory of evolution. Darwin published his theory, in the first edition of his book, "On the Origin of Species by Means of Natural Selection" (Davidson 2008:6) in 1858. The book offered a wealth of evidence in support of the idea of his theory of biological evolution. It is clearly written using plain English. It is arguably the most

brilliant and persuasive scientific textbook ever written. Thus it is not surprising that it has been very influential. Not only that, but as Nürnberg (2010:14) comments that, as a scientific theory, “The evolutionary paradigm offers the best set of explanations we have at present.” Although written 150 years ago it is still the basis for the neo-Darwinian synthesis that has added further evidence to support the original ideas created by Darwin.

The Oxford Dictionary of English (Soanes and Stevenson 2009) defines the evolutionary theory first set out by Darwin as, “The process by which different kinds of living organism are believed to have developed from earlier forms during the history of the earth.” This development is portrayed as a gradual process of descent with modification, over a long period of time so that organisms slightly better adapted to the environment and hence more likely to produce descendants survive. This is called the concept of the survival of the fittest by natural selection (Darwin 1872, 2008:51,52,55) and is based on the Malthusian¹ doctrine of the natural limitation of population growth.

In the last 100 years the Darwinian theory has been the subject of major revisions producing what is called as the “Neo Darwinian synthesis”. This synthesis integrates genetic studies with Darwin’s theory of evolution (Johnson 2009:35). It was concluded by the discovery of the structure of the double helix DNA by Watson and Crick (1953:737,738). This enabled the small incremental variations with positive survival value that natural selection operated on to be explained (McGrath 2009:175). The neo-Darwinian synthesis has added polyploidy², gene drift³ and genetic flow⁴ to the process (Grogan and Suter 2010:4.2.5, 4.2.7).

Darwin’s original theory had four main logical facets, which are still accepted. The first is that individuals, including siblings, in a population vary (Darwin, 1872, 2008:40-51). These variations are passed to offspring by the laws of inheritance (Darwin, 1872, 2008:22). This is now known to operate by characteristics carried in genes⁵ (McGrath (2009:171ff). More offspring are produced than the environment can support, so in accordance with Malthusian ideas there is competition for limited resources (Darwin, 1872, 2008:64-97). Those individuals whose characteristics make them best suited to the environment live and reproduce and have more offspring (Darwin, 1872, 2008:64-97).

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- 1 Malthus, 1776 – 1834, a minister of religion and an economist, developed the theory that population size increased exponentially until it reached a size that could no longer be supported from the environment when it would stabilize or decrease under conditions of famine and disease (Harman 2009:139).
 - 2 Polyploidy represents a special class of mutation and can occur via several routes: genomic doubling, gametic nonreduction, and polyspermy. Genomic doubling occurs in both animals and plants and involves a failure of cell division following mitotic doubling. Similarly, gametic nonreduction involves a failure of cell division during meiosis. Unreduced eggs are a common route to polyploidy in both animals and plants, as is unreduced pollen in plants. Unreduced sperm, however, appear to play a minor role in polyploidization in animals. The evolutionary significance of polyploidy remains a mystery (Otto, S. and Whitton, J. 402,403,401-437).
 - 3 Genetic drift is the variation (or change) in the relative frequency of different genotypes (genetic constitution of an individual organism) in a small population owing to the chance disappearance of particular genes as individuals die or do not reproduce (Modified definition in The Oxford Dictionary of English, Soanes and Stevenson 2009)
 - 4 Gene flow is the movement of genes between populations so that genetic material may be transferred from one completely unrelated organism to another (see under “DNA and molecular biology” below).
 - 5 The ODE defines a gene as, “a unit of heredity which is transferred from a parent to offspring which may determine some characteristic in that offspring”. It is technically defined as, “a distinct sequence of nucleotides forming part of a chromosome.” Nucleotides form the basic structural unit of DNA. Each chromosome consists of a DNA double helix bearing a linear sequence of genes.

4. CHRISTIAN RESPONSES TO DARWINIAN EVOLUTION

Holtman's (2010:106) research indicates that the opposition of many educators towards evolutionary theory seems to be largely determined by their religious beliefs. For Christians the prime factor would be their interpretation of the first three chapters of Genesis. Most of those who interpret these Genesis chapters literally would accept either, "Young Earth Creationism" - earth 5700 to 10,000 years old (Numbers 2006:11) or "Old Earth Creationism" - earth 4.5 billion years old (McGrath 2007:387). Most creationists believe that species or classes of life are separately and individually created. Many "Young Earth" creationists reject evolution altogether (Lever 2002:30). On the other hand "Old Earth" creationists accept that many extinct creatures existed in previous Geological periods and that there is a divinely directed "evolutionary" path from simple to complex.

Many of those who regard Genesis as metaphorical/ allegorical would probably adhere to "Evolutionary Theism". This accepts descent by modification either initiated or guided by the Creator. The bible is perceived not as a textbook of science but of "salvation-history", the writers speaking with the language and pictures of the time (Young 1979:53). This is a historic interpretation and has precedent in the works of Augustine (McGrath 2009:95ff.). Young (1979:43) quotes Augustine,

We do not read in the gospel that the Lord said 'I send you the Paraclete who will teach you about the course of the sun and the moon; for he wanted to make us Christians not mathematicians.'

Some educators may adhere to the intelligent design theory. This view accepts biological evolution, but it believes that there is evidence that a designer ordained its teleological goal. Intelligent design arguments are formulated in secular terms and intentionally avoid identifying the intelligent agent (or agents) they posit. Although the identity of the designer it is not stated it is often implicitly hypothesized that this designer intervened in a way that was only possible for a Creator God (McGrath 2007:387).

5. JUSTIFICATION FOR A THEOLOGICAL INTERVENTION

There are three compelling arguments for a theological intervention in the introduction of the teaching of Darwinian evolution in High Schools. The first is that the opposition to it has religious roots. Thus a theological intervention is necessary. Research into the antagonistic attitudes towards evolution of first year university students at the University of Cape Town stressed, "the importance of engaging with students prior conceptions" if these adverse perceptions were to be modified (Chinsamy and Plaganyi 2007:248).

The second is that is epistemologically justifiable. This is important since some would deny this as they see science and religion as non-overlapping "magisteria" (see Gould 2002:4, Berger 2006:90, Coyne 2009:10). Methodologically the life sciences and Christian theology do indeed represent two distinct areas of intellectual inquiry, yet philosophically they offer each other possibilities for cross-fertilization since the fields of knowledge they study epistemologically overlap (McGrath 2009:xiv). This is reinforced by the recent new emphasis on Trinitarian theology that has brought a new appreciation of the "centrality and importance of the traditional doctrine of the Trinity" (Venter 2011:3) that impacts upon natural theology.

McGrath (2009:27,28,72) has used this to redefine natural theology. A trinitarian perspective holds that the God who created the world, as revealed through Jesus the Son of God, continues to direct it through divine providence and guides those who wish to interpret it through the books of both nature and the Scriptures by the illumination of the Holy Spirit. Despite the

advocacy of post-modernism with its many truths a Christian faith that accepts the triune God as creator, sees only one all-encompassing absolute truth (Lennox 2009:13, 14). Thus the purpose of natural theology is to emphasize, “the resonance between the intellectual framework offered by the Christian faith and observation” (McGrath 2009:27,28).

The third reason is that science is now invading areas of knowledge that depend upon interpretation and not just an objective empirical observation of reality. Ruse’s (1982:322) definition of science as dealing only with, “the natural, the repeatable, that which is governed by law” is becoming less and less accurate. For a start, if Ruse’s definition is accepted, then the theory of Darwinian evolution is not a scientific theory (Aurbach 2009:698) and neither are the theories of cosmology, consciousness, and morality, since although they may be modelled mathematically, they cannot be confirmed by natural repeatable observations. So the magisterium of science is increasingly overlapping with the magisterium of metaphysics (Lineweaver 2009:157).

In fact both McGrath (2009:xiv), a PhD in molecular biophysics and a Professor of Theology, and Lennox (2009:13,14) an Professor of Mathematics and a Fellow in the Philosophy of Science, contend that history reveals that scientific theory, on which all scientific methodology is predicated, has never been just an objective issue. Whether it is admitted or not prior philosophical and theological assumptions have, of necessity, always influenced scientific interpretations. Although a scientist’s metaphysical commitments would not often decide his interpretation of how things work, they may well influence the interpretation of how things came to exist in the first place (Lennox 2009: 37). Kuhn’s (1972) influential theory of scientific revolutions adds support to this. Kuhn (1972:113ff) comments:

Surveying the rich experimental literature... makes one suspect that... what a man sees depends both upon what he looks at and also upon what his previous visual-conceptual experience has taught him to see.

In conclusion theologians, and Christians in general, do not just have to accept scientific interpretative theories, as opposed to those theories that can be verified through repeatable tests and observations. They have a mandate to criticize interpretive theories, from a perspective informed by science and theology, and to examine whether or not they can be integrated into the Christian vision of reality. This is the case with the interpretative theory of Darwinian evolution.

6. DEBATABLE ISSUES WITH THE EVIDENCE FOR DARWINIAN EVOLUTION

This is illustrated by the fact that the neo-Darwinian theory of evolution is developing all the time (Switek 2011:loc 319) and has some unresolved, debatable issues that need to be talked in the classroom if learners are to be taught to think. These are now discussed referring to issues raised Grogan and Suter’s (2010) textbook.

6.1 The fossil record

Geisler (1999:224) comments, “It is seldom fully appreciated that the only real evidence for or against evolution is in the fossil record.” Thus an important debate centres around whether or not the fossil record provides conclusive evidence for the theory. Many believe that it does such as Gould (2002), Dawkins (2009), Switek (2011), and Behe (2003). Yet it is admitted by many who are committed to Darwinian evolution that the fossil record is still sketchy (Wilmot & Wilson 2002:10, Marshall 2009:1; Switek 2011:loc 261).

The major area of debate is that of transitional fossils. Darwinian evolutionary theory, which advocates the main instrument of descent by modification as natural selection, suggests that there should therefore be many, many more transitional forms than those in stasis (that is

remaining the same over long periods of time) (Aurbach 2009:697; Jarvis 2010:DVD 2). Transition should be the normal state because of the theory of constant incremental modification. In fact some believe that the fossil evidence demonstrates the exact opposite. Gould's (1977:226) comment is still relevant,

The extreme rarity of transitional forms in the fossil record (which) persists as the trade secret of palaeontology... The evolutionary trees that adorn our textbooks have data only at the tips and the node of their branches; the rest is inference, however reasonable, not the evidence of fossils.

While a greater number of transitional forms have been discovered in recent years, such as in the horse, whale, bird, mammalian and amphibian lineages (Prothero 2009:489, Switek 2011:loc 350), the evidence is, in my opinion, less than overwhelming. This may be indicated by fact that a frenzied search still seems to be going on for transitional fossils. Recently forty-seven million year old *Darwinus maxillae* was heralded as a missing link⁶ in human evolution (Franzen et al 2009:e5723). Whereas it was later shown by cladistic⁶ analysis to be only very distantly related to the primates (Switek 2011:loc 183).

This debate is not helped by learners being given outdated or problematic examples that as evidence of evolution. This is unfortunately the case with Grogan & Suter's (2010:4.1.7,4.1.10) presentation of *Archaeopteryx*⁷ as an example of a transitional fossil and horse evolution as an example of direct descent by modification. Recent research has cast doubt upon the transitional nature of *Archaeopteryx* (see ODE:2009; Dzik et al. 2010:394-402; Xing Xu, et al 2011:465). In fact Switek (2011:loc 2285) admits, "that it is extremely unlikely that a direct line of descent from birdlike dinosaur to first dinosaur like bird will be found." As Ruben (2009 np) comments,

In some museum displays the birds-descended-from-dinosaurs evolutionary theory has been portrayed as a largely accepted fact, with an asterisk pointing out in small type that "some scientists disagree". But now there are more asterisks all the time.

Concerning horse evolution which is wrongly depicted as a simple straight-line process of descent by modification from many toes to one toe. Gould's (1997:57) comment is still applicable, "... the fossil record shows that the evolution of the horse looks more like an elaborate bush with many trends and even reversals!" (See also Switek 2011:loc 4099).

Therefore surely these are two bad examples to present to learners if they are to learn to trust and think about the scientific evidence for evolution? It only confirms the accusations of creationist literature that most school textbooks show the same, outdated, incorrect iconic examples of evolution as evidence (see Wells 2000:249ff, Strobel 2004:39,40).

6.2 Gene sequencing

The tree of life was central to Darwin's thinking. This tree is a record of how every species that ever lived is related to each other (Lawton 2009:34). The relationships on this tree appeared to be confirmed by initial research resulting from the gene sequencing of RNA and DNA. Collins (2007:128,129), head of the Human Genome Project, and also a professing evangelical Christian, believes that the close correspondence of relationships between animals inferred solely from their DNA sequences and those inferred from the comparative anatomy of living forms and fossils is extremely strong evidence for Darwin's theory.

6 Cladistics is a bio life science's technique whereby certain morphological traits in fossils or living creatures are selected and then compared with those traits in other creatures to determine whether they are absent, present or modified. Once all the information is compiled it is placed into a computer program that sifts through the data to discover which organisms are most closely related to each other on the basis of these traits postulated as shared characteristics inherited from a common ancestor (Switek 2011: loc 183).

7 *Archaeopteryx* is the name given to an apparently feathered creature with skeletal similarities to both birds and dinosaurs discovered in the Jurassic Solenhofen Limestone in Germany in 1861.

This interpretation has two major flaws, one philosophical and logical the other coming from recent scientific research. The logical difficulty as Lennox (2009:118), a mathematician, notes that arises from seeing DNA sequencing as proof of evolution is that it logically goes far beyond all evidence because the fact that species can be classified hierarchically into genera, families and phyla is not proof of Darwinian evolution. It is possible to classify any set of objects into a hierarchy, whether their variation is evolutionary or not.

The second problem is that DNA sequences sometimes do not conform to RNA sequences. The only theory that can explain this is that heritable descent is not always vertical but is sometimes horizontal in nature. Swapping of genetic material often seems to have crossed huge taxonomic distances. It happened in the microbial world of the Precambrian and still seems to be happening today, probably caused by viral agents. In fact it seems to be the rule in eukaryotes rather than the exception (McGrath 2007:40,41, Lawton 2009:36,37). This raises the possibility that Darwin's' Tree of Life might turn out to be an extremely complex bush criss-crossed with long interconnecting lines of horizontal rather than vertical heredity.

6.3 Irreducible complexity

Darwin himself raised the problem of how to account for the evolution of organs that could only operate if they were perfectly formed, such as the eye. Thus he wrote,

If it could be demonstrated that any complex organ existed, which could not possibly have been formed by numerous successive, slight modifications, my theory would absolutely break down (Darwin 1872:2008:136).

He immediately adds, "But I can find no such case", and then (1872:2008:133-138) attempts to demonstrate how the eye may have developed. Dawkin's (1986:77ff, 86ff) has since made a more recent attempt to explain the evolution of the eye.

This is an example what has become know as the problem of "irreducible complexity". An irreducibly complex system is a single system composed of several well-matched, interacting parts where the removal of any one of the parts causes the system to effectively cease functioning. Thus it cannot be produced by slight, successive steps therefore would not be selected for by the process of natural selection. If such an irreducibly complex system can be proven to exist then it would be a powerful challenge to the theory of evolution by natural selection (Behe 1996:39).

Recent research has accentuated this problem by revealing the incredible complexity of many organs and physiological processes at the molecular level. Behe (1996:22), who accepts modification by descent revisited the eye, arguing that, "Each of the anatomical steps and structures that Darwin thought were so simple actually involves staggeringly complicated biochemical processes that cannot be papered over by rhetoric." In fact the possibility of even getting near to producing a workable eye, as a random process by natural selection, is mathematically an enormous figure (Behe 1996:36-39). Schroeder (2009:733,750) calculates that this figure is something like 10 to the power 260. This means that it is impossible for such a random process to produce complex life within the time it is calculated that the universe has existed.

The debate continues, however. Schroeder (2009:731) believes that this "intelligent design" argument has two weaknesses. It has been discovered that one formerly supposed irreducibly complex system could function with a component missing. This is the Dolphin blood clotting system which functions perfectly well without the Hagemann factor, which is necessary for humans (see Robinson et al 1969). Secondly Conway (2008:46,49,50, 64) suggests there may be a natural evolutionary teleological design mechanism that is yet to be discovered, although he does concede that even this could have metaphysical implications.

6.4 Ontogeny and phylogeny

In the last edition of the "Origin of Species", Darwin (1872:2008:323-339) uses Haeckel's concept that "ontogeny recapitulates phylogeny"⁸ as evidence for evolution. Grogan and Suter (2010:4.1.18) reproduce Haeckel's (1874, np.) diagrams of embryos that seem to show that they are all strikingly similar in their early stages. This is interpreted as illustrating that all life came from the same ancient ancestor, and is therefore evidence of evolution (Strobel 2004, 35ff,57).

It is an area of great controversy, some embryologists discrediting Haeckel's diagrams and the conclusions he drew from them soon after they were produced (Wells 2003:179; Hopwood 2006). At certain stages in early development, vertebrate embryos do look alike, at least in the gross anatomical features, but Haeckel seems to have altered the drawings to prove his theory. Despite this the debate is not over because Richardson's (1997:91-106, 2003:495) work seems to indicate that the Haeckel's theory cannot be completely dismissed and may indeed provide some support for Darwinian evolution.

The debate is surely not helped by learner's begin exposed to Haeckel's original sketches, in view of his (Hopwood 2006:295) admission of inaccuracies in the drawings. As Gould (2000:3) comments, "Textbook writers should be ashamed of the way that Haeckel's drawings have been mindlessly recycled for over a century as evidence for evolution." If we are to teach learners how to think and convince doubting educators that Darwinian evolution is a credible theory then they must be presented with the most recent and accurate scientific truth.

6.5 Macroevolution

Many unreservedly accept the evidence for what may be called "microevolution", but have reservations about macro-evolutionary mechanisms (Aurbach 2009:692). Microevolution is "variation within prescribed limits of complexity" (Lennox 2009:101). Two examples of microevolution are Darwin's Galapagos finches (Darwin 1872:2008:304,305; Davidson 2008:5) and the way that bacteria develop resistance to antibiotics (Lennox 2009:101).

Macro-evolution refers to large-scale innovation, the coming into existence of qualitatively new genetic material producing new organs, structures, and body plans (Lennox 2009:101). It is problematic for some. Hoyle (1987:7), mathematician and astronomer wrote,

As common sense would suggest, the Darwinian theory is correct in the small, but not in the large. Rabbits come from slightly different rabbits, not from either soup or potatoes. Where they come from in the first place is a problem to be solved, like much else on a cosmic scale.

Wesson (1991:206), a palaeontologist, adds that he does not know of any good fossil record of macro-evolution nor can Müller's (2003. 51) observation be lightly dismissed,

The canonical neo-Darwinian theory ... is intended to explain neither the origin of parts, nor morphological organization, nor innovation... Selection has no innovative capacity: it eliminates or maintains what exists.

Natural selection can account for micro-evolution but there are questions about whether or not it can be extrapolated to a macroevolutionary level since it can only select from the genetic material that exists already. It cannot produce the new genetic material required for major structural change (Jarvis 2010:DVD2). This remains the problem with Gould & Eldridge's (1977) theory of "punctuated equilibria" whereby the evolutionary process at the macroevolutionary level proceeds by major, random, chance processes such as mass extinctions, producing major organic changes.

Two ideas have been developed which may explain the increase of complexity discovered

⁸ "Ontogeny recapitulates phylogeny" is the theory that the development of the embryo of every species (ontogeny) fully repeats the evolutionary development of that species (phylogeny),

in the fossil record in conjunction with natural selection, these are known as the theories of “emergence” (see Gould 2002:656-666) and the concept of “evolutionary development” (see Gould 2002:1095-1101). These can only be dealt with briefly in this article and the reader is referred to the references for further detail.

“Emergence” is the view that creation entails the origination of levels of multileveled complexity whose properties emerge under certain conditions that did not exist at the origin of the Universe (McGrath 2009:206). The theory utilizes the concept that the properties of the whole are often unpredictably greater than the properties of the sum of the constituent parts (Nürnberg 2010:71). Kauffman (2000:127-128) argues, concerning emergence, that biological evolution is inherently a self-organizing process in which complexity evolves in accordance with a “fourth law of thermodynamics”. This is that life has an innate tendency to explore opportunities for building greater complexity. This theory must at the moment be regarded with caution since it is simply an interpretation, however reasonable, of reality. Neither does it explain the causality of the new genetic material needed for macroevolution, only what may happen with the rearrangement of existing material as in microevolution.

Evolutionary development (or Evo-Devo for short) is the scientific concept that increase in complexity may result from the rearrangement of existing genetic material (Gould 2002:1099). It is a complex and rapidly expanding field of research. It is based upon experimental research that discovered that genes, such as regulatory Hox genes, can modify the body plans of organisms during embryonic development, by switching on or off cascades of gene sequences within DNA (Switek 2011:loc 1509). This alters developmental processes to create new and novel structures from the old gene networks (such as bone structures of the jaw developing to become the ossicles of the middle ear) or turn on junk⁹ DNA gene sequences preserved in a host of very different organisms to create similar structures, such as the eye in molluscs, insects, and vertebrates (Tomarev et al. 1997:2421-2426; Pichaud & Desplan 2002:430-434). However general hypotheses remain hard to test because organisms differ so much in shape and form (Palmer 2004:828-833). Moreover, whilst this may explain the mechanism behind microevolution, it still has to face the problem of how descent by modification can produce the complexity we see today during the limited time span available since life has existed on the earth.

All of this confirms the results of recent research that, “Biology is vastly more complicated than we thought” (Lawton 2009:39), with profound implications for evolutionary theory.

7. SUGGESTIONS FOR A SCIENTIFICALLY-INFORMED THEOLOGICAL INTERVENTION

There is no doubt that Darwinian evolution must be taught in High Schools in South Africa in order to equip the learners to face the modern world. Yet this article argues that both educators and learners be allowed to and encouraged to think about every aspect of the Darwinian theory. Despite the large amount of evidence that can be interpreted as supporting the theory, its unassailable status cannot be assumed. There is no place for Grogan & Suter (2010:4.6.1) to dismiss alternative theories with the comment,

The intelligent design view arose from a creationists’ standpoint and was developed to discredit evolution. Someone caustically called it ‘creationism dressed up in a tuxedo. This undermines the curriculum’s stated emphasis on the need to consider alternative faith-based and indigenous knowledge systems (Holtman 2010:104).

An authoritarian approach demanding that educators teach a scientific theory they do not believe in will only exacerbate an already unhealthy situation. The introduction of its teaching

⁹ Collins (2007: 111) defines junk DNA, as long sequences of DNA that does not seem to be involved in any way in producing proteins.

needs to be done gradually in dialogue with educators since the teaching of Darwinian evolution is, for many educators, a radical innovation. Roger's (2003:168) theory of the diffusion of innovations suggests that, "an individual's decision about an innovation is not an instantaneous act. Rather it is a process that occurs over time."

The process therefore requires taking into account their religious views towards evolutionary theory. They need to be exposed to the various acceptable theological interpretations of the first three chapters of Genesis as well as the most accurate and recent scientific evidence, with an honest explanation of the problems. It thus needs to be facilitated by ministers, pastors, and theologians with an understanding of evolution informed by biology, zoology and geology.

It must be demonstrated that belief in Darwinian evolution need not lead to atheism or agnosticism. Indeed Darwin (1872:2008:357) shared that he saw no "good reasons why this volume should shock the religious feelings of anyone." Indeed the teaching of evolutionary theory not only has problems but also is an opportunity. It is an opportunity to help Christian educators think through the challenges presented by Darwinism as a spur to developing a more mature Christian faith that boldly and intellectually interacts with the secular society that South Africa is, for better or worse, becoming. It is an opportunity to discuss the interface between religion and science and to think about the "fine-tuning" of the Universe that has recently been discovered by cosmologists, physicists, mathematicians and biologists and its implications for faith (for further information see McGrath's, "A Fine-Tuned Universe, the Quest for God in Science and Theology", details in the bibliography).

Scientists and educationalists need to realize that from a practical, philosophical and theological perspective science and religion cannot be separated. If we refuse to take seriously contending interpretations of nature we teach that science is just a matter of authority. Grogan & Suter (2010:4.1.19) state that the theory of Darwinian evolution challenges learners to think for themselves. If that is a good argument for learning about evolution, it is also a good argument for looking at alternative views because if learners are to think for themselves, it will mean that they must be free to disagree with accepted wisdom where it is knowledgeably disputed. Not so?

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KEY WORDS

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