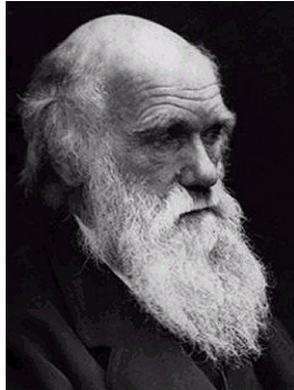


Theories of Evolution

Stratford Caldecott



The 200th anniversary of the birth of Charles Darwin in February 2009 saw a plethora of articles and books, conferences and debates about the meaning of evolution and its compatibility with religious faith.

According to John Locke, writing in 1690, it is impossible to conceive that “bare incogitative Matter should produce a thinking intelligent Being,” such as Man. A century later, the Scottish philosopher David Hume played with the idea that what he called the “continual motion of matter” might produce all the appearances of “wisdom and contrivance” in the universe – but in the end, when it came right down to it, he could not take his own idea seriously. It was another century before the European Enlightenment finally gave birth to what we now call the theory of *evolution by natural selection*, associated primarily with the name of Charles Darwin (although the word “evolution” itself came from Herbert Spencer). Articulated, clarified, qualified and deepened by others, this idea – according to modern exponents such as Daniel Dennett and Richard Dawkins – has swept aside the essentialist, dualistic and teleological philosophies of the Middle Ages, and shown itself capable of explaining the origins of mind and morality in a blind, purposeless and mechanical process starting from nothing at all.

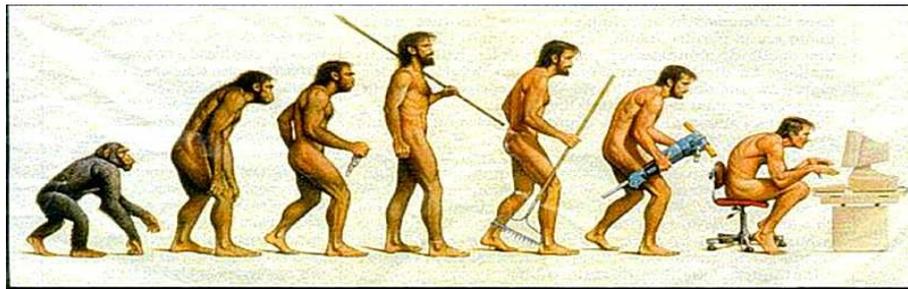
As if in order to remove the last leg on which a religious believer or creationist might try to stand, Dennett in his bestselling book *Darwin’s Dangerous Idea* suggested that even the *laws of nature* governing the origin of species may have themselves evolved from absolute chaos through a process of trial and error, extending through a series of alternative and successive universes governed by quite different laws and constants, in many of which the evolution of life would have been impossible. Design can emerge from order and order from chaos “via an algorithmic process that makes no use of pre-existing Mind”. Thus for Dennett, the idea of evolution by natural selection at least potentially “unifies all of biology and the history of our planet into a single grand story”.

Despite the anti-religious virulence of Dennett and Dawkins, Catholics generally, from the Pope down, prefer to avoid head-on confrontation. Most are happy to accept the current scientific view that the world is millions of years old, and find relief in the fact that the Big Bang hypothesis seems to chime so well with the Genesis account of creation from nothing.^[1] The only non-negotiable items seem to be the direct creation by God of the human soul,^[2] and the derivation of

the whole human race from a single couple (Adam and Eve). For the moment, neither of these Catholic dogmas seems particularly problematic. The empirical evidence seems to be in favour of monogenism (the genetic origin of the present human race from one ancestral couple rather than several), while the divine creation of the soul is open to a conveniently wide range of interpretations.

This friendly truce, however, is not likely to continue. The tendency in the evolutionist camp is always to turn the theory of evolution into something more than it is, indeed to transform it into a substitute for religion, as the philosopher Mary Midgley has shown in her book *Evolution as a Religion*. E.F. Schumacher wrote in *A Guide for the Perplexed* (1977), “Evolutionism is not science; it is science fiction, even a kind of hoax. It is a hoax that has succeeded too well and has imprisoned modern man in what looks like an irreconcilable conflict between ‘science’ and ‘religion’.”

The quasi-religious fervour with which Darwin’s “grand story” has been promoted by some sectors of the intellectual establishment suggests that what is at stake here is more than meets the eye. The theory does not merely happen to be true: in a sense, for many people, it *has to be true*, for no other type of explanation would be acceptable to the modern mind. What is at stake is modernity itself, for which evolution provides an overarching paradigm.



The Mainstream Theory

Evolutionary theory aims to explain the origin of life and all its present variety of forms: that is, the whole range of individual organisms normally categorized into species, genus, family and kingdom. It postulates the emergence of complex living organisms from non-living matter by way of a much smaller number of less complex ancestors. It claims that all life on earth can be traced back to one primitive organism, developing spontaneously and by chance, probably from a primordial soup of electrified chemicals.

This account has a certain intuitive appeal. After all, it is a matter of common observation that offspring are rarely if ever exactly the same as their parents. Variations on species-type naturally occur, some of them quite radical, a few of them perhaps making the individual stronger or fitter or cleverer. A variation that favours survival or reproduction in a generally hostile, competitive environment is more likely to be passed on to the next generation. One can imagine those variations gradually, over long periods of time, resulting in the emergence of new strains. If so, why not whole new species?

The precise mechanism by which variations occur and may be passed on from one generation to another was not known to Darwin. The discovery of chromosomes and the development of the science of genetics seemed at first to supply that need. However, gaps in the fossil record (in

popular parlance “missing links”) remained troubling to some throughout the 19th and 20th centuries. Some evolutionists suggested that the various species we know today did not emerge slowly but rapidly, in jumps that took place over thousands or perhaps even just hundreds of years, rather than the millions hypothesized by Darwin. The original theory was therefore adapted by suggesting ways in which variations could be brought about more rapidly through genetic mutation and/or environmental pressure (the inheritance of acquired characteristics being ruled out by the lack of an appropriate mechanism). Stephen Jay Gould has been the best-known exponent of this theory of “punctuated equilibrium”.^[3] As for the attempts to replicate the creation of life under laboratory conditions, these have not so far been successful.

The best known opponents of the evolutionary account (whether fast or slow) are the *biblical creationists*, who believe that God created the various separate species in a sequence of distinct acts described in the Book of Genesis, perhaps even in six days of twenty-four hours each. This does away with the difficulty of explaining incredible variations between different forms of life in terms of environmental pressures working on spontaneous genetic variation, but introduces a whole series of other problems, not least the existence of the fossil record. The extreme creationist view is not taken seriously even by most Christians; and it has to be said that the methods and arguments of “creation science” do little to allay the fears of irrationalism which haunt this debate. It has been rightly said that a simplistic creationism “is the best thing that could have happened to Darwinism, the caricature of religion that has seemed to justify Darwinist contempt for the whole of religion.”^[4]

God of the Gaps?

A more sophisticated critique of the Darwinian paradigm on the basis of science alone is provided by exponents of “Intelligent Design” (ID), a theory promoted by the Discovery Institute and the Access Research Institute in the United States. Two of the foremost Christian magazines in America, *First Things* and *Touchstone*, have been persuaded of the seriousness of this attack on scientific orthodoxy, which is presented in a series of books by Philip R. Johnson (*Darwin on Trial*, 1991), Michael Behe (*Darwin’s Black Box*, 1996), Lee Spetner (*Not By Chance*, 1997) and William A. Dembski (*The Design Inference*, 1998). (Users of the Internet can find the case laid out at www.arn.org.)

Intelligent Design claims that biological systems at the molecular level are “irreducibly complex”. This means that they are made up of many complicated parts and subsystems, all of which have to be in place in order for the system as a whole to perform a useful function – such as enabling the organism to survive and reproduce. Its exponents rely on complex technical arguments in biochemistry and probability theory, but the argument resembles one which has often been made by opponents of evolution (including G.K. Chesterton). How could a complex organ such as the eye emerge by a series of stages, each of which would have to have been selected by evolution, when the eye itself is only of any benefit to the organism when it is functioning *as an eye*? Transposed to the biomolecular level, the argument allegedly becomes even stronger. Perhaps the complexity of life does not get built up from simple components at all, but exists from the beginning.

It is important to note that the proponents of Intelligent Design claim to make their case without appeal to divine revelation, even though the exponents of ID tend to be Christians, and some at least have joined the Orthodox Church.^[5] The Access Research Network web-site carefully distinguishes ID from so-called “scientific creationism.” And rather than proposing to infer God’s existence or character from the natural world, ID simply claims “that intelligent causes are

necessary to explain the complex, information-rich structures of biology and that these causes are empirically detectable.”

In the tradition of William Paley, ID claims that the failure of science to explain complex structures leads to a single inescapable conclusion: the existence of God – or at least of an Intelligent Designer responsible for the existence of those structures. This is the claim that causes most controversy. For most scientists, the difficulty of explaining complexity is no failure, but simply a stimulus to further research. In any case, many simply do not accept the scientific claims being made here. And among them are some who also argue that ID offers a cripplingly restricted view of God’s actions. Cambridge palaeontologist Simon Conway Morris is one. Unimpressed by the ID argument for impossible jumps in biochemical evolution, he observes the tendency of different species to arrive at the same structural solution to a similar need. Thus despite the lack of any direct genetic connection, wings or eyes or limbs may resemble each other without any need for a designer to intervene in the process. Conway Morris, though, is a Christian. What he is reaching towards is an understanding of evolution not as a random, wandering process, but as highly ordered – shaped by an underlying logical structure that makes certain developments almost inevitable.[\[6\]](#)



The Holistic Model

The last few decades have seen the gradual emergence of a new field in developmental and evolutionary biology called *epigenetics*. This focuses less on the genetic mechanism itself, than on the surrounding influences on the genome. It takes a more holistic view of evolutionary biology, suggesting that emergent properties are not entirely caused by the component parts of the organism, but that interaction between parts also plays a major role.

Epigenetics is the latest scientific manifestation of an organicism that itself has a long ancestry. Other attempts to establish an organicist view of evolution have been made on the basis of systems theory. Organicists argue against Intelligent Design on the grounds that, like the genetic determinism of Richard Dawkins, it assumes an unfolding order based entirely upon genetic control – even if the two theories differ on where that order ultimately comes from. Life is still reduced by ID to a mechanism, albeit one that has been designed. The epigeneticists prefer the view of life as a

process in which new and complex properties may emerge as the result of interactions between the various parts.

Organicist writers look for the secret of emergent order in the *science of complexity*, a branch of systems theory. Leading exponents such as Humberto Maturana, Ilya Prigogine and Fritjof Capra argue that greater complexity develops less through environmental pressure or selection from outside than through self-organization from within. A living organism may be viewed as a dynamic system, an open or “dissipative” structure (absorbing energy and dissipating entropy to its environment) which maintains its own stability through positive and negative feedback – the flow of information. “Life” is defined as a process found in some, though not all, types of dissipative structure (a hurricane and a whirlpool would be examples of non-living dissipative structures). Following Gregory Bateson and Maturana, Fritjof Capra goes one step further, and identifies the life process with cognition itself, proposing thereby to overcome the Cartesian split between mind and body.

Organicism and the scientific theories of emergence are compatible with a belief in evolution, but are they resonant or consonant with a Christian understanding of how God works in the world? Although the systems thinkers I have just mentioned are opposed to reductionism and materialism as well as to Cartesian dualism, it is possible to argue that they are reductionistic in a new sense. What they oppose is “mechanistic reductionism”, or the view that organisms are machines which can be completely understood by analyzing them into their component parts. But some of them, at least, appear to be replacing this with a kind of “information reductionism”. The word *autopoiesis* (self-making) applied to emergence sounds scientific enough, but if all it really signifies is that new forms of order appear from nowhere it looks very like an appeal to magic.

By reducing mental processes to the flow of information, these organicists are also ignoring the spiritual or interior dimension of consciousness. Jerry Fodor once strikingly commented that “Nobody has the slightest idea how anything material could be conscious. Nobody even knows what it would be *like* to have the slightest idea about how anything material could be conscious.” Consciousness itself is something completely other than matter, energy or the flow of information. It has no colour, shape or weight. The brain events that are observed to take place when consciousness changes can be no more than correlates. Unless we allow this, the human person will dissolve in the dance of information just as surely as it dissolved into the flux of matter and energy during an earlier phase of modern science.

Yet the organicists are surely moving in the right direction. From a religious, or a specifically Christian, point of view there is much scope in the epigenetic approach for a richer understanding of God’s relationship with the world. It moves away from the reductionism that deadens the religious spirit. “All of the perversions that human freedom can inflict upon being and its qualities always aim at one thing: the annihilation of the depth dimension of being, thanks to which being remains a mystery even, indeed precisely in its unveiling.”^[7] Hans Urs von Balthasar, from whom this quotation is taken, is by no means averse to the scientific unveiling of reality. He simply wants to insist that this unveiling not destroy the “depth” out of which reality emerges. To equate the brain with the mind, or the substance of consciousness with the transmission of information, is one more way of trying to eliminate this “depth dimension” of being. Only within this vertical dimension does it make sense to seek for God, and for a divine influence on the unfolding or evolution of creation. Any other attempt to combine religion and science will lead to a “process” God so identified with creation that he loses all transcendence. ^[8]

Levels of Reality

So let us look more closely at the idea of a depth dimension of being, and move on from there to the possibility of an evolutionary science that would take account of a distinction between different levels of reality. Christians already have a robust understanding of how this works in everyday life in the concept of divine Providence. No matter how accidental a series of events may appear to be, Christians often believe them to be foreseen and permitted, if not positively intended, by Providence, and to be unfolding according to an eternal plan. (The problem of whether divine foreknowledge of human action deprives us of free will need not detain us, since it was adequately answered long ago. If God exists, he exists above time, and so he does not see our decisions before we make them, but rather sees them eternally *as we make them*. Since he plans the world in eternity, he can take into account every free act that will ever be made.)

References to Providence are, however, normally found in discussions of spirituality rather than science. The language of spirituality, moreover, tends to be personal rather than impersonal, thus removing it from the realm of scientific discourse. According to J.-P. de Caussade in his classic *Sacrament of the Present Moment* (sometimes called *Abandonment to Divine Providence*), God speaks to us not in human words but through whatever happens to us, moment by moment. Setting aside the implication that God resembles us sufficiently that we can regard him as “speaking”,^[9] we may take this as a reference to another kind of causality, at right angles to the kind investigated by science but not in contradiction to it. The events of my everyday life have their normal (efficient, material) causes, the kind studied by science, but they also have a higher explanation in terms of some kind of “divine speech”. The Christian therefore has faith in a higher level of order or meaning, supervening upon and assuming the lower-level order of material cause and effect. I know there is a perfectly rational reason for my friend to have phoned at five o’clock. But my friend may also have phoned at five *in answer to a prayer*, or because God knew that I needed to hear what that friend would say precisely then, rather than two hours earlier.

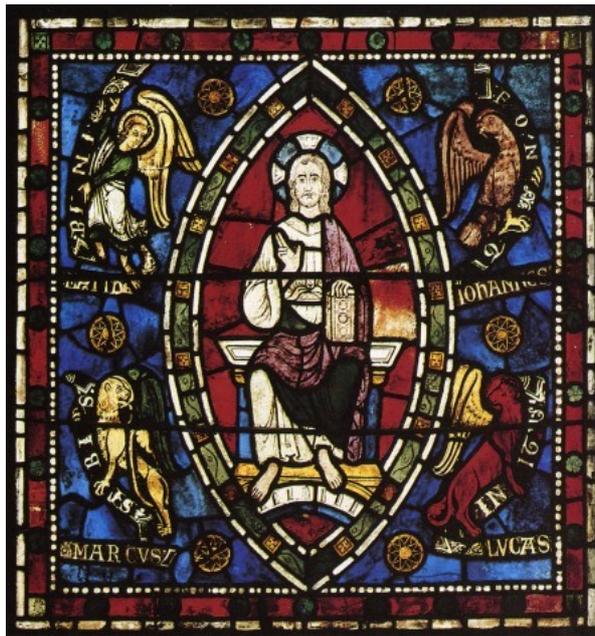
To apply the same idea on the material level and in the realm of biology, a given genetic mutation might well appear random or accidental, and be adequately explained as far as science is concerned by a set of physical causes, whilst still possessing another cause entirely, a cause that we might describe as descending “vertically” rather than affecting events in the temporal sequence “horizontally”. It owes its existence to the God who brings it (along with all its physical and temporal causes) out of nothing, and it belongs to an order that only becomes evident when the ultimate purpose of God is revealed.

Thus faith in Providence need not change the way the Christian does science, in the way that the faith of the creationist in the literal truth of Genesis is supposed to do. Nevertheless it allows for a sense of purpose, of teleology (goal-directedness), within the physical world observed by science.

In the 19th century, St George Jackson Mivart, a Catholic opponent of Charles Darwin, argued along these lines, and was praised by Cardinal Newman for exposing the logical insufficiency of Darwin’s theory.^[10] In the 20th century, Michael Polanyi analysed the phenomenon of emergence and concluded that evolution, and life itself, must have been originated by the action of an “orderly innovating principle” of a higher order, the action of which is “released” by random fluctuations and “sustained” by fortunate environmental conditions.^[11] More recently, the Faith Movement in Britain has been aiming to reconcile the theory of evolution with Catholicism in what it calls a “new synthesis”. Its founder, the late Father Edward Holloway, posits that God works through evolution

to bring about an ordered cosmos. Christ is the embodiment and master of a Law of Unity and Direction, the center of human and universal history. In the words of Fr David Barrett to a Faith Theological Symposium in 2003, the Mind of God is “actively and dynamically knowing and willing the creation as a unity in development, an evolving whole. So the Unity-Law is identified with and through every aspect of the material universe, and is at the same time the relationship of all these parts as a unity to the Mind of God.” Thus, “Control and direction, space and time, meaning and purpose are descriptions of how evolving matter is constituted by Mind in one perpetual act of knowing and willing.”[\[12\]](#)

The most sophisticated attempts to harmonize faith and science consider the “laws of nature” investigated by science, and in conformity to which life appears to evolve, not as somehow detached from God, but as intentional acts of the Divine Mind. They are ways of describing the effects in time and space of the eternal wisdom of God, ordering all things to an end. That end or goal is found in the Person of Christ, human and divine. The divine Idea in which the creation itself is comprised and towards which it converges is both the supreme Universal, and a particular, concrete individual who is born, dies and is resurrected within the creation.[\[13\]](#) The paradox of the Incarnation signifies nothing less than the appearing within the world of its true centre, orienting the cosmos towards its beginning and its end, its *alpha* and its *omega*. (In mechanics this would be known as an “attractor”. It is as though the flat surface of the world had been given a shape by the insertion upon it of a weight so heavy that all the lines of space and time now converged upon it.)



Philosophy and Genesis

If evolution is so easy to reconcile with religious or Christian belief, why do so many people feel that it gives them a stick to beat Christianity into the ground? For the answer we must venture a bit further into philosophy. The philosophical system that lies behind most of the familiar forms of evolutionism is nominalism, which first became popular in Europe around the time of the Black Death. The nominalists and their successors (positivists, pragmatists and other schools of thought hostile to traditional metaphysics) believe that the real world consists entirely of individual particles, elements or energies and their relationships, which can be described in a variety of ways. It is only the way in which we *choose to describe* certain things that determines whether they belong to one species or another. On this assumption there can be no reason to prevent one type of

thing turning into another, given the right circumstances and enough time: all that needs to happen is for one collection of particles to be sufficiently restructured for re-description to become necessary.

The threat to religion comes not from evolutionism, but from reductionism. Nominalist types of philosophy recognize only one single ontological level – two if you include God. Evolutionism and creationism are therefore siblings, born from the same philosophical parent. If the world consists only of matter and (perhaps) God, then the diversity of living organisms must have emerged spontaneously through the mutation and recombination of matter, or (perhaps) by the imposition of the divine will directly upon it. Of these two explanations, the creationist theory destroys the very possibility of scientific investigation. Is there an alternative that does not destroy science, but rather widens and deepens it? Such might have been the hope of C.S. Lewis, when in *The Abolition of Man* he wrote of a regenerate and non-reductive science of the future, possibly along the lines suggested by Goethe: a science of qualities “which would not do even to minerals and vegetables what modern science threatens to do to man himself”.

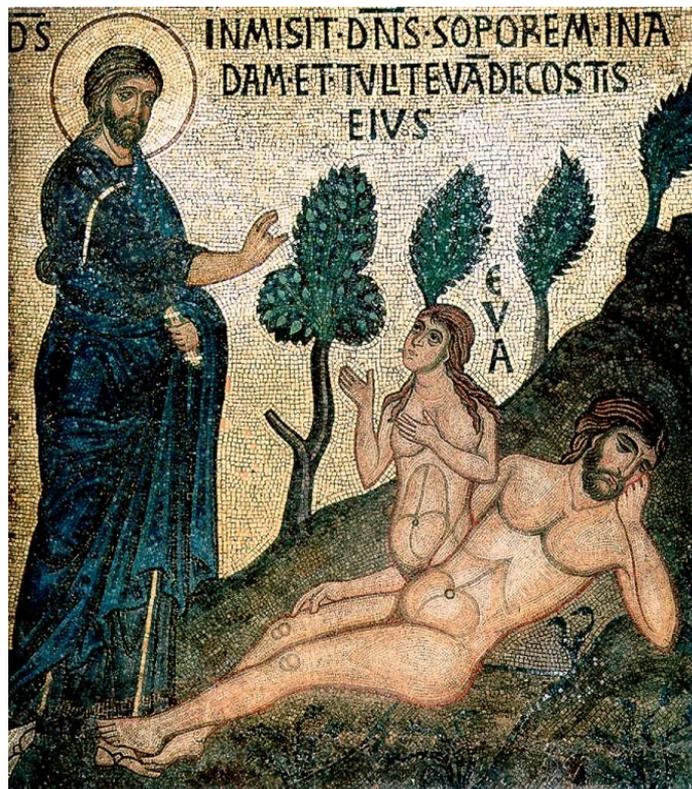
As the organicists and systems thinkers argue, the way forward for science lies in the postulation of more levels of reality than simply two. The re-introduction of a multi-dimensional ontology and final causality would remove an unnecessary constraint upon scientists – as a number of them have realized. Michael Polanyi acknowledged it by positing the existence of morphogenetic fields originating from above the material level and determined by a final cause.^[14] Arthur M. Young defines four levels of being, each possessing different degrees of freedom and constraint, linking them to the four causes of Aristotle.^[15] Wolfgang Smith has illuminated many of the paradoxes and puzzles of modern physics by reference to traditional cosmologies, including the Thomistic.^[16] It is on some intermediate level of reality that we might locate the “attractors” that give a shape to the evolutionary process, if Conway Morris is right.

With this possibility in mind we may return to the Biblical texts and read them in quite a different way than the creationists or their critics. Genesis hints at quite a complex series of conditions or states existing before our present world, and it may be possible to conceive of these in terms of events taking place at different ontological levels rather than simply in an earlier time. Before the Fall, Genesis tells us, animals did not eat each other’s flesh. Certain Patristic commentaries assume that in this state, also, sexual reproduction would have been unnecessary, and that the “coats of skins” later given by God to Adam and Eve were not bear-skins, as the modern reader perhaps imagines, but the animal-like flesh in which we now find ourselves.^[17] In the Garden, where Man was at first set apart from the rest of creation, death and sickness were unknown, which suggests that this state was even exempt from the entropy which defines our temporal state of existence, putting it right outside the known universe of modern science.

Science has conceded that different physical laws might pertain within the first few nanoseconds of the Big Bang, or in the depths of a black hole where space and time have been forced into a singularity. What if the Bible, in its own way, was also trying to describe a very different world to our own, one in which Nature is in the process of formation? St Augustine’s reflections on the days of creation in *De Genesis ad Litteram* may be taken as one example of a Christian interpretation along these lines. For Augustine, time itself is a creature, while the six “Days” represent not periods of time that can be measured in hours, or even millennia, but distinct aspects of an instantaneous creative act as viewed by the angelic intelligences. The creative act of God, he taught, terminates in the *seminal reasons*, spiritual seeds of all things projected into prime matter. These then unfold in time as the actual or corporeal existence of individual species or creatures.

The concept of the seminal reasons provides a useful intermediary between the mind of God on the one hand, where all things that might exist are present as ways in which the divine Essence could be imitated (the Thomistic way of describing the Forms in their highest aspect), and the corporeal world around us on the other, in which certain things exist and others do not.[18] The seminal reasons are reminiscent of the “implicate” or “generative” orders and “holomovement” hypothesized by physicist David Bohm, initially as a way of accounting for certain quantum phenomena.[19] They may be the true “morphogenetic fields” of each species, the missing links at the very beginning of each evolutionary chain, needed to explain the emergence of new forms in nature.

All of which, though it does no more than hint at certain possibilities that may have been overlooked in the debate between evolutionists and creationists, brings us back to a remark by Goethe: “One cannot properly speak of many problems in the natural sciences if one does not draw on metaphysics for help; but not that school-and-word wisdom; rather that which was, is and shall be before, with and after physics.”[20]



Further Reading

Michael D. Aeschliman, *The Restitution of Man: C.S. Lewis and the Case against Scientism* (Eerdmans, 1998).

David Bohm and F. David Peat, *Science, Order and Creativity* (Routledge, 1989).

Henri Bortoft, *The Wholeness of Nature: Goethe's Way of Science* (Lindisfarne and Floris Books, 1996).

John Brooke and Geoffrey Cantor, *Reconstructing Nature: The Engagement of Science and*

Religion (T&T Clark, 1998)

Karl W. Giberson and Donald A. Yerxa, *Species of Origins: America's Search for a Creation Story* (Rowman & Littlefield, 2002).

Etienne Gilson, *From Aristotle to Darwin and Back Again: A Journey in Final Causality, Species, and Evolution* (University of Notre Dame Press, 1984).

Mary Midgely, *Evolution as a Religion: Stranger Hopes and Stranger Fears* (Methuen, 1985).

Seyyed Hossein Nasr, *Religion and the Order of Nature* (Oxford University Press, 1996)

Seraphim Rose, *Genesis, Creation and Early Man: The Orthodox Christian Vision* (Saint Herman of Alaska Brotherhood, 2000).

David L. Schindler (ed.), *Beyond Mechanism: The Universe in Recent Physics and Catholic Thought* (University Press of America, 1986).

Wolfgang Smith, *The Quantum Enigma: Finding the Hidden Key* (Sherwood Sugden, 1005)

Michael Stenmark, *Scientism: Science, Ethics and Religion* (Ashgate, 2001).

The present article is a revised version of a piece that appeared in Second Spring 6.

[1] We should remember, however, that all scientific theories are provisional. Those who tie their theology too closely to the latest consensus in science usually live to regret it. The arguments for creation *ex nihilo* (our of nothing) are quite independent of the eternity or otherwise of the created order.

[2] “Theories of evolution which, in accordance with the philosophies inspiring them, consider the spirit as emerging from the forces of living matter or as a mere epiphenomenon of this matter, are incompatible with the truth about man,” according to Pope John Paul II in 1996.

[3] The theory has been severely criticized by, among others, Simon Conway Morris of Cambridge.

[4] Marilynne Robinson, cited in Michael Hanby, “Creation without Creationism: Toward a Theological Critique of Darwinism”, *Communio* XXX:4 (Winter 2003), p. 679. Michael Hanby’s critique of Darwinism is one of the most important in recent years.

[5] The link is made explicitly by Philip E. Johnson in his Introduction to *Genesis, Creation and Early Man*, by Seraphim Rose (see Further Reading).

[6] See his book *Life’s Solution: Inevitable Humans in a Lonely Universe* (Cambridge University Press, 2004).

[7] Hans Urs von Balthasar, *Theo-Logic: Theological Logical Theory*, Vol. I (Ignatius Press, 2000), pp. 16-17

[8] For further, more sophisticated discussion of epigenetics and the links to Christian theology see W. Malcolm Byrnes, “Epigenetics, Evolution and Us”, *The National Catholic Bioethics Quarterly* 3:3, Autumn 2003, pp. 489-500. This article is also available in the Archive of the *Second Spring* web-site. See also Rudolf B. Brun, “Principles of Morphogenesis in Embryonic Development, Music and Evolution”, *Communio* XX:3 (Fall 1993). Balthasar transcends the “process” view by means of his concept of “theo-drama”. Historical developments are due to the dramatic interaction of created with uncreated freedom. Freedom is real because, from the point of view of anyone

within time, the future is not yet determined. Theo-drama is applied to evolution in Celia Deane-Drummond, *Christ and Evolution: Wonder and Wisdom* (SCM Press, 2009).

[9] Religious believers know that God cannot be directly known or accurately described but employ analogies that at least gesture in the right direction. This complex question (the “analogy of being”) is not addressed in the present article.

[10] As a Catholic organicist, Mivart believed that “an internal power is a great, perhaps the main, determining agent” for directing changes in organisms and producing convergence to common structures” (J. Brook and G. Cantor, *Reconstructing Nature*, p. 258). Unfortunately Mivart was marginalized in the debate, drawn into Modernism and excommunicated by the Church for reasons unconnected with his opposition to Darwinism.

[11] Michael Polanyi, *Personal Knowledge: Towards a Post-Critical Philosophy* (Harper & Row, 1964), p. 386.

[12] David Barrett, “The Unity Law Throughout the Plan of Creation”, *Faith* 35:4 (July/August 2003), p. 6. Unfortunately, the new synthesis makes the human soul an exception to the process of evolution without explaining how this does not render the whole account incoherent.

[13] Cf. Hans Urs von Balthasar, *A Theology of History* (Ignatius Press, 1994).

[14] As he puts it, guided by a “gradient of achievement”: Michael Polanyi, *op. cit.*, pp. 398-400. Polanyi’s metaphysics and theology are usefully analysed in John F. Haught and D.M. Yeager, “Polanyi’s Finalism”, *Zygon* 32:4 (December 1997).

[15] For an introduction to Young’s theory see Frank Barr online at www.arthuryoung.com/barr.html.

[16] For a succinct summary of Smith’s views, see his article “*Sophia Perennis* and Modern Science” in L.E. Hahn, R.A. Auxier and L.W. Stone (eds), *The Philosophy of Seyyed Hossein Nasr*, Library of Living Philosophers XXVIII (Open Court, 2001). Roughly, the “physical” world discovered and described by modern science occupies a distinct ontological level in a spectrum that runs from pure Act (God) to Potency (*materia prima*, or the “lower waters” of Genesis). It is below the corporeal world of everyday experience, within which our measuring instruments are situated, but above the *materia prima*. In fact Smith identifies it with the *materia secunda signata quantitate* – as Werner Heisenberg himself put it, “just in the middle between possibility and reality”. The indetermination and chaos that have been made so much of in the quantum world pertain to the element of potency in all things, and the relationship between potency and act is illustrated by the “collapse of the wave function” which takes place when an observation is made. The corporeal domain itself is determined by substantial forms of a higher order, including those of living organisms and of Life as such.

[17] St Gregory of Nyssa is the best example. Among modern theologians, Hans Urs von Balthasar is one who argues that in the Edenic state, as in the Virgin Mary, fecundity and virginity would not have been separated. See his *The Christian State of Life* (Ignatius Press, 1983), pp. 94-103. It should be noted that this was not the line taken by St Augustine or St Thomas Aquinas.

[18] There is no space here to explore the differences between this conception and that of the *logoi spermatikoi* of the Greek patristic tradition. For Maximus, it appears, the *logoi* are the uncreated divine intentions; as such presumably they would be at the root of Augustine’s seminal reasons but cannot be identical with them. See Lars Thunberg, *Man and the Cosmos: The Vision of Maximus the Confessor* (SVS Press, 1985), pp. 137-43. Cf. Alexei V. Nesteruk, *Light from the East: Theology, Science and the Eastern Orthodox Tradition* (Fortress Press, 2003), e.g. pp. 101-7. The latter is one of the most interesting recent attempts by a physicist to apply Orthodox cosmology to modern science, and we hope to review it in a later issue.

[19] David Bohm describes how he arrived at his idea in the final chapter of David L. Schindler (ed.), *Beyond Mechanism*. Bohm’s language is strikingly reminiscent of the fifteenth-century

writer, Cardinal Nicholas of Cusa, who also speaks of the “unfolded” and “enfolded” order, for example in Book 2, Chapter 3 of *On Learned Ignorance*. See Jasper Hopkins, *Nicholas of Cusa on Learned Ignorance: A Translation and an Appraisal of De Docta Ignorantia* (Arthur J. Banning Press, 1981), pp. 93-6.

[20] Jeremy Naydler (ed.), *Goethe on Science: An Anthology of Goethe's Scientific Writings* (Floris Books, 1996), p. 125. This area of metaphysical cosmology may be one in which the various great religious traditions – despite the important differences that divide them in others – may collaborate to the profit of science.