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Evolutionary Theory and the Creation Controversy

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Chapter 1
What Is the Story to be Told?

The famous 19th century German embryologist Karl Ernst von Baer, a contemporary of Darwin and an opponent of Darwin's theory of evolution, is reported to once have aptly characterized the scientific attitude as follows: "If in the course of scientific research I find myself using a balance, and God intervenes by pushing the lighter scale down so that it appears to be the heavier one, I'll have to get up and say – 'please, Sir, you complete the task at hand; under the present circumstances I cannot do it!'."

1.1 The Encyclopedia of Life: Noah's Ark Digitized

"A web page for every species known to live on Planet Earth": this was the vision developed by the renowned Harvard biologist Edward O. Wilson.[1] But with approximately 1.8 million species named and described, and many more yet to be discovered, this would not be an easy project. Each species would have its own web page, and as the species itself, its web page would continuously evolve, "dynamically synthesizing content ranging from historical literature and biological descriptions to stunning images, videos, and distribution maps." [2] This is the mission of the project that has its roots in Edward O. Wilson's proposal: the Encyclopedia of Life. The website of the project[2] invites everybody to help and contribute to the Encyclopedia of Life. This sounds familiar as such a public encyclopedia already exists on the worldwide web: "Wikipedia," the free encyclopedia with entries that are written collaboratively by volunteers around the world. Everybody can log in and enter a new article, or add to or edit an already existing one. If it is possible to motivate systematists, conservation biologists, bird watchers and butterfly collectors to contribute, the Encyclopedia of Life could become a dream come true: an

[1] Wilson, E.O. 2003. The encyclopedia of life. Trends in Ecology & Evolution, 18: 77–80.
[2] http://www.eol.org

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exhaustive catalogue of life, dubbed "a virtual Ark of Noah" in the media.[3] Would Noah's Ark, afloat in cyberspace, contain an inventory of Divine Creation? Or a catalogue of the biodiversity created through the process of the evolution of life on earth? What is the difference?

Well, it depends on the purpose and goal of the Encyclopedia of Life. If an illustrated list of every species were all there is to the Encyclopedia of Life, it would not really matter how species came into being. Whether species originated through Divine Creation or through descent with modification, they are essential parts of our natural environment and hence worth every effort to protect them. But to protect endangered species, one must have deep knowledge about them. An enriched Encyclopedia of Life thus promises to become a formidable tool for all those active in nature conservation programs. And yet, like any other dictionary, the Encyclopedia of Life would require some structure and some organization for it to become an easy-to-use tool for scientists and laypeople alike. Dictionaries are organized in alphabetical order. So species entries into the Encyclopedia of Life could be also ordered alphabetically. This was, indeed, the suggestion of one of the leading initiators of the whole project. One could imagine that Noah released animal species from his Ark in the alphabetical order of their names, or that reports on biodiversity assessments of remote rain forest territory list plant and animal species in alphabetical order. Similarly, one can imagine searching for a species in the Encyclopedia of Life according to where its name slots into the alphabetical order of all existing species names.

But then, there is something counterintuitive about such an alphabetical listing of species names. Children quickly learn the difference between dogs and cats, lizards and snakes, birds and bats. Visitors to a zoo expect to see eagles in the birdhouse, tree shrews in the mammal house, and fishes in the aquarium. In nature, species do not group in the alphabetical order of their names, but instead form groups marked out by their "nature." The neighbor's cat and a dog that lives further down the street might be of similar size, and yet the cat seems to be closer to a lion, whereas the dog shares its characteristics with wolfs. Both birds and bats are warm-blooded, and yet bats seem to be more closely related to mice than to sparrows. There is a reason for this, which is spelled out by evolutionary theory: bats and mice share a common ancestor, which is not shared by birds. With evolutionary theory in place and well researched for more than 150 years, there opens a possibility to order plants and animals not only alphabetically but on the basis of kinship. Descent with modification is the process that governs the growth of the Tree of Life. On this tree, species nest according to their evolutionary relationships.

The science that groups species in a hierarchically structured natural system according to their evolutionary relationships is called systematics. But to systematically arrange the Encyclopedia of Life requires expert knowledge.

[3]Radio-Canada http://www.radio-canada.ca/nouvelles/Science-Sante/2007/05/09/001-encyclopedie-vie.shtml?ref=rss (no implication of 'Intelligent Design' or 'Science Creationism' is intended. Accessed November 9, 2009).

However, this sets limits to the community of authors competent enough to enter species descriptions into the Encyclopedia of Life, if the latter is to be organized so as to reflect the structure of the Tree of Life. Bird watchers and beetle collectors might be highly competent to enter species descriptions in alphabetical order, or edit the one that already exists, as new information is gathered. But they might be unaware of, perhaps not even interested in, the latest analysis of the evolutionary relationships of the species that they observe and collect. A manual on the proper management of natural history collections, published by the US National Park Service, suggests a variety of arrangements that can be used to organize bird and mammal collections. These may take the form of an arrangement of species according to their evolutionary relationships as specified by a "recognized taxonomic authority,"[4] or an alphabetical arrangement of species within their family or genus. A dispute thus arose amongst the initiators of the Encyclopedia of Life. To get it on its way and develop it fast, some argued that it requires input from a broad community. The Encyclopedia of Life should be modeled on Wikipedia, to which a worldwide community of users can contribute. Others argued that access to the Encyclopedia of Life should require a port of entry that exercises scientific scrutiny. To have available information on plant and animal species reliably and meaningfully stored, species should be arranged in a phylogenetic system that reflects their evolutionary relationships. "Nothing in biology makes sense except in the light of evolution," the renowned population geneticist, Theodosius Dobzhansky, once said.[5] The philosophers of biology Kim Sterelny and Paul Griffiths[6] paraphrased this famous line as "nothing makes sense in biology except in the context of its place in phylogeny," that is, in the context of its place on the Tree of Life.

As the debate heated up, a proponent of the alphabetical arrangement rejected the need for phylogenetic information content in the Encyclopedia of Life. Indeed, the US National Park Service manual calls upon some "recognized taxonomic authority" on which the evolutionary arrangement of collections would have to be based. But who is to provide such authority if it is true, as one of the participants in the discussion once remarked that "90% of our current science is wrong anyway, and will have to be revised in the future"? This, of course, is a very strong statement, revealing a very skeptical attitude toward science. It is certainly true that hypotheses about evolutionary relationships of species are subject to change as new information becomes available. Science is supposed to be a self-correcting system, its theories subject to rejection or revision in the light of new evidence. That is what separates a scientific theory from a dogma. But to call contemporary science wrong by 90% is surely much too strong. If contemporary evolutionary biology is

[4]Handling and care of dry bird and mammal specimens. Conserve O Gram, September 2006, Number 11/9.

[5]Dobzhansky, T. 1973. Nothing in biology makes sense except in the light of evolution. The American Biology Teacher, 35: 125–129.

[6]Sterelny, K., and P.E. Griffiths. 1999. Sex and Death. An Introduction to Philosophy of Biology. The University of Chicago Press, Chicago, p. 379.

wrong by 90%, why should the doctrine of Intelligent Design not be respected as a serious alternative to natural selection?

1.2 Natural Theology and the Doctrine of Intelligent Design

The main focus of the doctrine of Intelligent Design is what its proponents call "irreducible biological complexity." Harking back on Wiliam Paley's old "watchmaker analogy" as expounded in his notorious "*Natural Theology*" of 1802,[7] the proponents of Intelligent Design highlight biological structures such as the bacterial flagellum, which is thought to reveal a mechanistic complexity so sophisticated that its evolution cannot possibly be satisfactorily explained on Darwin's theory of natural selection. "Intelligent Designers" portray the theory of natural selection as an example of a universal law of nature that – according to the teaching of the great philosopher of science Sir Karl Popper – must be considered falsified if only a single contradictory case can be convincingly documented. Karl Popper opened the sixth German edition of his famous book on "*The Logic of Scientific Discovery*" (of which much more later) with a quote from the immortal German philosopher Immanuel Kant: "The *modus tollens* is a form of rational argumentation, which concludes from effects to causes, and thus delivers proof not only very stringently, but also very easily. Because, if only one single false conclusion can be drawn from a statement, then that statement is false." The ultimate falsifying example highlighted by "intelligent designers" is the flagellum, a filament of complex internal structure with which bacteria of a "pool" of species collectively referred to as *Escherichia coli* propel themselves forwards. However, questions that are elegantly glossed over in this account, and that will be addressed later in this book are as follows: what is a universal law of nature, how can it be falsified, and does modern science – in particular modern evolutionary theory – in fact deal with such laws and their falsification?

Proponents of "Intelligent Design" do not name the engineer responsible for the flawless function of the flagellum in protozoans, regarded by some as simple organisms presumably nested within the root-system of the Tree of Life. However, it is easily appreciated that the "watchmaker analogy" barely conceals the one and only Divine Creator as The Cause of organismic complexity. And indeed, if scientific knowledge is doomed to remain woefully incomplete, why should an initial act of Divine Creation not be integrated into evolutionary theory to render that theory complete? Even Darwin, perhaps to temper the outrage of his unprepared readers, concluded his "*On the Origin of Species*" of 1859 with the remark: "There is grandeur in this view of life, with its several powers, having been

[7]Paley, W. 1802. Natural Theology: or Evidences of the Existence and Attributes of the Deity, Collected from the Appearances of Nature. J. Faulder, London

originally breathed into a few forms or into one"[8] – "breathed" by whom? On which basis do biologists reject an initial act of Divine Creation, which in itself would not necessarily invalidate the claim for the existence of a hierarchical order in nature that is accessible to empirical investigation? Even if Noah released animal species from his ark in the alphabetical order of their names, this would not invalidate the claim that the Plan of Creation, originating in the thought of a Divine Creator, contained a blueprint of a Great Tree of Life, where all plant and animal species slot into a hierarchically structured classification according to their "affinities." To decipher the "affinities" of organisms and to order them accordingly would be tantamount to reading God's mind in nature. This was, indeed, the opinion of one of the foremost experts in zoological systematics of his time, Louis Agassiz (1807–1873). Just 2 years before the publication of Darwin's "*Origin*," Agassiz published his famous "*Essay on Classification*"[9] in 1857, arguing that one of the noblest tasks of zoology is the discovery of the natural hierarchy into which all living beings can be sorted. But for Darwin, the "affinities" of species were causally rooted in common descent, whereas for Agassiz they were rooted in Divine thought. If a hierarchical classification can be discovered – rather than being invented – by biologists, then this hierarchy cannot be considered artificial, but must exist in nature: "To me [i.e., Agassiz] it appears indisputable, that this order and arrangement of our studies are based upon the natural, primitive relations of animal life." Yet this being so, "those systems, to which we have given the names of the great leaders of our science who first proposed them" could "in truth" represent nothing but "translations into human language of the thoughts of the Creator."[10]

How should we counter Agassiz' assertions? After all, hierarchical order might just be a brutal fact of nature that requires no further explanation, as Agassiz himself realized: "a system may be natural, that is, may agree in every respect with the facts in nature. . . but merely as the expression of a fact existing in nature – no matter how."[11] The historian of science, Mary P. Winsor, found it characteristic of Agassiz to hide this point in a footnote at the bottom of the page, as this insight might well have proven fatal for his theory of classification.[12] The reason is that Agassiz added an explanation to what he declared to be an empirical fact based on observation, while declaring in a footnote that the explanation he proffered was not necessary for the recognition of this fact. Likewise, Darwin found the hierarchical classification of organisms to be a fact of nature, amenable to empirical investigation, yet he again was not quite satisfied with leaving this fact alone. Instead, he

[8]Darwin, Ch. 1859. On the Origin of Species. John Murray, London, p. 490.

[9]Agassiz, L. 1857. Essay on Classification. Contributions to the Natural History of the United States, Vol. 1. Little, Brown & Co., Cambridge, MA.

[10]Agassiz, L. 1859. Essay on Classification. Longman, Brown, Green, Longmans, & Roberts, and Trübner & Co., London, p. 9.

[11]Agassiz, 1859, ibid., p. 8, Footnote 1.

[12]Winsor, M.P. 1991. Reading the Shape of Nature. Comparative Zoology at the Agassiz Museum. The University of Chicago Press, Chicago, p. 25; see also Rieppel, O. 1988. Louis Agassiz (1807–1873) and the reality of natural groups. Biology & Philosophy, 3: 29–47.

likewise added an explanation for its existence, which is descent with modification: "Descent being on my view the hidden bond of connexion which naturalists have been seeking under the term of the natural system."[13]

1.3 The Impact of Modern Philosophy of Science

Again it is Karl Popper who claimed to have shown the way of how to choose between the explanations of the natural system offered by Agassiz and Darwin, respectively. Popper's earliest claim to fame was his insight that there is no theory free observation. According to this thesis, which will require further discussion later on, brute facts of nature cannot be intelligible. But Darwin offered an explanation for the existence of the natural system that is grounded in natural causes, whereas Agassiz, explanation transcended the natural course of events by appealing to a supra-natural Creator. Popper thought that theories of science that concern natural processes or events should be testable, and potentially falsifiable through tests, whereas any explanations that transcend the natural course of events and for this reason are not testable must be considered metaphysical and hence be excluded from scientific discourse. Along such a demarcation line, Darwin's theory would qualify as scientific, whereas Agassiz' explanation would gain no purchase in scientific discourse because of its metaphysical character.

Popper's views on the philosophy of science became widely known and broadly accepted within the scientific community and the public at large. Scientific theories, he proclaimed, are those that can be tested by experiment, and as a consequence of such tests, it can potentially be found to be false. The converse, that scientific theories could be empirically tested, and potentially found to be true, was denied by Popper. Taking this position to its letter would mean that scientists can never know whether their theories are right, they can only know when and why they have gone wrong. This is the root of the claim that science is doomed forever to remain incomplete, and that 90% of contemporary science may be wrong and in need of revision in the future. Such a highly skeptical view of science became popular in the 1960s and 1970s, mainly as a reaction against the logical positivists' defense of the possibility to confirm scientific theories, and by some – including some highly respectable scientists – such skepticism is defended to the present day. As will be shown, it was promoted not only by Popper, but also – albeit in different ways – by three other very prominent philosophers of science, each with a large audience amongst the broader public: Thomas S. Kuhn, Paul Feyerabend, and – to some lesser degree – Imre Lakatos. Today, the history of the philosophy of science has turned another page or two. The battle against the logical positivists has been fought, supposedly won, and then found to have thrown out the baby with the bath water. A search is underway to clear former misunderstandings, and to give

[13]Darwin, 1859, ibid., p. 449.

empiricist philosophers proper credit where credit is due. As will be shown, Popper's authority has somewhat faded, and his strictly falsificationist attitude toward scientific theories has been recognized as internally inconsistent. The philosophical foundation on which Thomas Kuhn built his sociology of science has been revolutionized, and a new approach toward the justification of the undisputable success of science has been formulated. Science certainly cannot take possession of absolute truth, but it can – and does – do better in "tracking the truth"[14] than Popper, Kuhn, and Feyerabend would have admitted. A new generation of philosophers takes a different approach in the analysis of science and its success in space exploration, biotechnology, and medicine, to name just a few of its branches. Whether a universal law or not, whether falsifiable in a Popperian sense or not, natural selection theory can be – and is – used successfully in the development of computer software and vaccines against HIV.

1.4 An Outline and Some Historical Context

The story to be told, then, is how the science of biology came to free itself from claims of initial Creation or Intelligent Design. The story will also reveal that claims of initial Creation, or Intelligent Design, as they are issued today, are in fact an old hat. The relevant issues were hashed out first in France in the late eighteenth and early nineteenth century, later in Victorian England in the middle of the nineteenth century. In 1844, Robert Chambers anonymously published a book titled "*Vestiges of the Natural History of Creation*." It presented nature not as a Tree of Life, but rather as a Ladder of Life, and argued that life had evolved along that ladder from mushroom to human, on the basis of purely natural causes, without any intervention from above. This book created an enormous controversy,[15] and was particularly opposed by Hugh Miller, who in 1849 published his "*Foot-Prints of the Creator or, the Asterolepis from Stromness*." Miller hoped not only to expose the fatal flaws in Chambers' treatise, but also those of an earlier French version of an evolutionary theory, that of Jean-Baptiste Lamarck, which provided guidance to Chambers' writings. Miller's "*Foot-Prints*" was considered the ultimate refutation of transformationist ideas, until it was recognized that its interpretation of the Fossil Record was flawed.[16] Darwin naturally followed the controversy closely, learning from it which pitfalls to avoid in his own rendition of evolutionary theory, which he would publish in 1859, and which would be the one to catch on and change the world.

[14]Psillos, S. 1999. Scientific Realism. How Science Tracks Truth. Routledge, London.

[15]Secord, J.A. 2000. Victorian Sensation: The Extraordinary Publication, Reception, and Secret Authorship of Vestiges of the Natural History of Creation. The University of Chicago Press, Chicago.

[16]Secord, 2000, ibid., p. 282.

To enter into the debate between Chambers and Miller, we first need to find some historical context. It is necessary to understand the contemporary sciences of biology, geology, and paleontology (the study of fossils) to appreciate the impact of Chambers' book, and the force of Miller's rebuttal. With the Christian interpretation of Ancient Greek philosophers and naturalists, we enter a created world. We learn what the characteristics of such a created world are, a world that just "is," that never truly "becomes." It is a world governed by universal laws of nature, which themselves never change, just as the fundamental structure of the universe likewise never changes. It is true that, looked at from our vantage point, planets are in continuous motion, but they move on seemingly eternal, immutable orbits that can be described in the equally time-less language of mathematics. By contrast, a chicken embryo seems to undergo drastic changes in size, shape, and composition during its development. On the one hand, astronomers had no "problem of change." On the other hand, biologists developed ingenious theories to deal with change as is apparent in the developing embryo, desperately seeking to avoid the paradox that change creates in a created world.

However, time obtains from the passing of nature, as the philosopher Alfred North Whitehead so aptly observed, and with the passage of nature change crept into theories of biology after all. Offspring inherit a variable mixture of characteristics from their parents, and occasional malformations can happen: it was the study of development and regeneration of organisms that made it impossible for biology to deny change. Once this insight had become unavoidable, books such as those written by Lamarck and Chambers became possible. The dispute between Chambers and Miller turns much on geological, paleontological, and biological evidence. Major issues in the debate were the nature of the Fossil Record, and whether the succession of fossilized forms of life through geological time supported Chambers' vision. Evolution is a process of change, and evolutionary theory is an explanation of the causes that drive this process of change. But for an evolutionary process explanation to be applied, we first have to have a pattern of a natural order in need of an explanation. Systematists classify organisms: it was the eighteenth century Swedish botanist Carl von Linné (generally known as Carolus Linnaeus) who brought methodological rigor and strength to this discipline. But if we classify organisms, is the resulting classification purely logical in nature, as Miller thought, or does it reflect order in nature, as Chambers claimed? Is the classificatory system created in the classifiers mind, or is it discovered through the study of nature? And if order in nature is discovered rather than created by systematists, what kind of order is it? Does such a natural system correspond to the metaphor of a ladder, as Chambers thought, or to the metaphor of a branching tree, as Darwin thought? As embryos develop from the fertilized egg to the hatchling and to the sexually mature adult, they gain in complexity. Is it true that embryonic development follows along the ladder of life, as Chambers thought, and that the Fossil Record again mirrors this ladder of life, delivering a threefold parallelism of the natural system with embryonic development and the succession of fossils through layers of rock? The ladderized natural system, embryonic development, and the Fossil Record were all thought to display the same pattern of progress toward greater complexity of life

forms, and it is this pattern that Chambers explained through his "Law of Development." Miller used the then oldest known fishes of curious yet highly complex structure that he had dug up in the Old Red Standstone of Scotland to highlight apparent imperfections of the threefold parallelism and on that basis to refute its causal explanation through the hypotheses about natural causes that Chambers had offered.

But Miller not only confronted Chambers on the basis of the evidence the latter had adduced in support of his vision but he also shifted the debate to a philosophical level. What is respectable science? How should science be properly pursued? How is science to be organized, and what are the appropriate methods for the various scientific disciplines? What are "laws" of nature, and how should a proper scientific explanation be structured? What can, and what cannot, count as relevant evidence? What role does observation play in science, and how far can a scientist legitimately push his/her speculations before losing credibility?

If all this sounds familiar, it is because the very same questions are on the table again today, with respect to Creation Science and the doctrine of Intelligent Design. This is the point at which Karl Popper, Thomas S. Kuhn, Imre Lakatos, and Paul Feyerabend come in. Popper believed in the unity of the scientific method, but through the method he championed he rendered science incapable of obtaining any positive knowledge. Kuhn thought that science is a product of its historical and socio-political context. In different historical and social contexts, different scientific research programs will be guided by different theories. According to Kuhn – or at least according to some interpretations of his writings – the scientists of a given period construct the world they claim to discover, at least in part, through their own theories. When scientific theories change, the world of scientists changes with them. Imre Lakatos sought a synthesis between Popper's falsificationism and Kuhn's sociology of science through the introduction of his concept of institutionalized research programs. Finding much he liked in Kuhn's philosophy, Feyerabend finally took the socio-political approach to science one crucial step further forwards, declaring that there is really no such thing as a proper scientific method. Well, if that is true, how are we to judge evolutionary theory against Creation Science?

We will see what reasons there are to conclude that Popper, Kuhn, and Feyerabend drew a far too pessimistic picture of science, a picture that can certainly be much improved upon. But it will also become clear that when they talked about science, Popper, Kuhn, and Feyerabend took physics as the paradigmatic example of a natural science, and that was it. Ironically, it is also from physicists and astronomers that Darwin earned the most serious objections to his theory of evolution at the level of a scientific (as opposed to a social, moral, or theological) debate. Darwin characterized his "principle of natural selection" as "one general law, leading to the advancement of all organic beings, namely multiply, vary, let the strongest live and the weakest die."[17] However, the astronomer John Herschel objected that his "law" did not qualify as one of those universal laws of nature that a proper branch of science

[17]Darwin, 1859, ibid., p. 244.

seeks to discover. Darwin spoke of the "laps of ages" it took for species to evolve, but the physicist Lord Kelvin delivered putative "mathematical proof" (now known to have been erroneous) to show that the earth was too young to accommodate Darwin's theory of evolution. However, biology, and especially historical biology, is not physics. With Darwin, evolutionary biology became an autonomous scientific discipline, with different methods and different schemes of argumentation than those in physics. The reception of Darwin's theory in continental Europe makes this particularly clear: "While it is true that biology has to continue its development as a science about natural laws, it is also true that biology cannot be only a science about natural laws. This is because research that involves organisms concerns not only lawful, but also historical relations. In that sense, biology differs from physics and chemistry both in method, as also in the scope of inquiry."[18] Even if the arguments of Popper, Kuhn, and, perhaps to a somewhat lesser degree, those of Feyerabend gain some purchase with respect to physics, they do not do so in the same way with respect to historical biology. Popper claimed science to progress through conjecture and refutation. Theories are conjectured, then tested against experience, and rejected if they fail the test. Darwin, in contrast, set out to trace the traces that evolutionary history had left behind in the Fossil Record as much as in the living world.

[18]Uhlmann, E. 1923. Entwicklungsgedanke und Artbegriff in ihrer geschichtlichen Enstehung und sachlichen Beziehung. G. Fischer, Jena, p. 111.

Chapter 2
The Problem of Change

An evolving world is a world of change. A created world does not change. It just is. Or if it seems to change, the change is only apparent, as it is preconceived and preordained by the blueprint of Creation. Change is paradoxical: how can something change and yet remain the same? How much remodeling can be done to a house before we no longer call it the same house, but a new and different one? Some Ancient Greek philosophers solved the 'problem of change' through the concept of dynamic permanence: planets are in constant motion, continuously changing their position relative to other heavenly bodies, but they travel in immutable, eternal orbits. These orbits can be described in terms of universal laws of nature, which in turn can be expressed in the timeless language of mathematics.

The concept of dynamic permanence is less easily applied to organisms. The developing chicken appears to change continuously, but here, organs such as the heart, the brain, and the limbs seem to come into existence without having been apparent before. Pre-evolutionary biologists solved the 'problem of change' through the doctrine of pre-existence. The entire organism pre-exists since the time of Creation, folded up into minute dimensions, and encapsulated either in the spermatozoon's head portion, or in the female egg. Embryonic development, a process of change, then becomes the mere unfolding of structures that are preformed and that already pre-exist since the beginning of time, albeit too small to be seen. Such an unfolding of pre-existent structures during the development and growth of the embryo was the original meaning of the term 'evolution'.

2.1 Change in a Created World

"Evolution" literally means "unrolling" or "unfolding." Something that is unfolding is something that takes part in a process, or that is a process itself. A process, in turn, is a chain of events that naturally stretches through time. Evolutionary theory is about natural processes that extend through time and result in change. An evolving world is an ever-changing world. This contrasts with a created world that does not change. A created world is just the way it was created. Nothing comes, nothing goes, and everything remains the same always. Any apparent change is just what it is – apparent, that is preconceived and preordained through the blueprint of Creation. Can something come from nothing? Can something dissolve into nothing? What is it

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to say that "something changed"? It is to say that one and the same thing underwent change? But how can anything change and yet remain the very same thing, rather than become something else as a consequence of change? This is the paradox of change. Creation is not changing one thing into another. Instead, it puts things into place. Things are put into space and time through Creation. Thereafter, they stay the same and remain unchanged.

If the world is an evolving world that undergoes constant change, the Creator cannot be of this world. Change implies time, and time obtains from the passing of nature, as the philosopher Alfred North Whitehead puts it: "There is no holding nature still and looking at it."[1] But the Creator is eternal and timeless. Neither does He come out of the future, nor does He recede into the past. He resides outside time and space, so to speak. To enter into an evolving world would mean to enter into change, to enter into time, to abandon timelessness, and to abandon eternity. And yet, at some point, at the beginning of all things, the Creator seems to have undergone change, when He enacted His Creation. But to say that the Creator is eternal, existing beyond time, and to also say that the Creator entered into time with His Creation, is a logical contradiction. The Creator cannot reside outside time and enter into time at one and the same time, that is, at the beginning of all things. Such a logical contradiction is nonsensical. To speak in logical contradictions makes no sense, it means to say nothing.

A created world therefore cannot change, and if change appears to occur to the human observer, this cannot be real change. Human powers of perception are limited to processes that extend through time and space. The apparent change that takes place in the world must be a mere impression of change, an illusion the human observer takes away from his/her fleeting, every-day observations. The underlying structure of the universe must remain the same. The universe is timeless, eternal, governed as it is by equally eternal, timeless, and universal laws of nature that constitute the blueprint of Creation. This is a very comfortable world to live in. It is a secure world, a world one can know something about. A world that functions like a universal clockwork can be explained in terms of its underlying machinery that never changes. This world is one the past of which can be known, and in which the future can be planned accordingly. If the fundamental structure of the universe is eternal, if the laws governing the universe are eternal too, then knowledge of these laws translates into knowledge of the universe. Observed effects can be explained as a consequence of their cause, the past becomes explicable, the future becomes predictable. It is only the very beginning that remains unexplained. That's where the paradoxical Creator comes in, and with Him the Plan and Purpose of Creation.

So what does this Plan of Creation look like? Well, there seem to be fire and air, water and soil. There seem to be rocks and minerals, plants and animals. Some living organisms look almost like rocks, as do some lichens and mushrooms. Some animals look almost like plants, as do some sea anemones and sponges. Worms

[1]Whitehead, A.N. 1920. The concept of nature. Tarner lectures delivered in Trinity College November 1919. Cambridge, Cambridge University Press, UK, p. 14.

appear to be lowly creatures in comparison with fish. Fishes appear to be lowly creatures in comparison with parrots and tree shrews. Lions appear more sophisticated in their pursuit of prey than salamanders. Sea gulls appear more sophisticated in their care for offspring than snakes. At the top of this ladder of life sits the human being, distinguished from all other living beings by the capacity for rational reasoning, and by the capacity to communicate such reasoning through language. The Creator resides outside Nature; angels provide the link between Him and humans. A thread seems to run through this Creation, linking lower with higher forms of life.

The direction from bottom to top in the ladder of life is not meant to imply change, however, even if its rungs appear to have been put into place at different times during the history of the planet earth.It is, instead, a static arrangement of life in a Great Chain of Being that reflects the immutable Plan of Creation.[2] The concern in laying out the Plan of Creation is not change, but the order that pervades nature instead. The Great Chain of Being was not related to a historical process of the emergence of increasingly complex forms of life, where something genuinely new successively evolves from the old. It was meant to express a hierarchical classification of the contents of nature, according to the Book of Creation. Eighteenth century French aristocrats extended the ladder of life from the realm of nature into the realm of society. They justified the social hierarchy of human society as a corresponding expression of the eternal Plan of Creation: firm, immutable, safe, and secure. French biologists of the eighteenth century, who were part of this aristocracy, or at least maintained close ties to its members, chastised speculations about genuine change in nature as infected with the seed of atheism. They went to great length to explain away any apparent changes in nature to provide the doctrine of an immutable, eternal, Great Chain of Being with a scientific foundation.[3] Theories departing from that doctrine were castigated as godless, immoral, and subversive, and their proponents prosecuted. But change prevailed: The French Revolution swept away the ancient social order, and the theory of evolution swept away the doctrine of a static Great Chain of Being.

Later still, time was found to be relative, matter was found to be a form of energy, and quantum mechanics showed the basic structure of the universe to be indeterminate, and the laws of nature to be probabilistic. The past still is explicable, the future still is predictable, but not with absolute accuracy nor with a certainty that is rooted in the eternity of Creation. The blueprint for Creation, if ever there had been one, would have been blurred. We are stuck in a logical contradiction again: the Creator cannot be almighty and omniscient, yet undecided and ambiguous. Albert Einstein, who wanted to unlock the ultimate secrets of the universal clockwork, rejected such fundamental indetermination of the world, as was proclaimed by quantum mechanics. God, he insisted, “does not play dice” with the universe.

[2]Lovejoy, A.O. 1936. The Great Chain of Being. Harvard University Press, Cambridge, MA.

[3]For a good illustration of these tensions see Sonntag, O. 1983. The Correspondence between Albrecht von Haller and Charles Bonnet. Huber, Berne.

The quantum mechanics community replied: "Einstein, stop telling God what to do with his dice."[4]

How could all these changes happen? Why and how did science try to avoid the problem of change by explaining change away? And how did it come about that change became a dominant perspective of the modern worldview? To trace these changes, and with them the tension between the Creator and the passing of nature, is the topic of this book.

2.2 The Problem of Change

Western traditions in philosophy and natural science originate with Ancient Greece. Philosophy investigates the world of thought, and natural sciences investigate the world of matter. Natural sciences strive to acquire explanatory knowledge of the material world and of its inhabitants. One of the wonders of this world is the harmonious movement of the stars in the nightly sky. Fascinated by the stars since ancient times, people have been observing the nightly sky, studying the regular movements of celestial bodies. This is a most fascinating enterprise indeed. The nightly sky seems forever to be subject to continuous change: the sun rises in the morning and settles in the evening; the moon comes and goes with a regularity that parallels oceanic tides. Time passes as changes occur and reoccur. And yet, the language of mathematics, which itself is timeless, eternal, and universal allows us to describe those regular and recurrent changes in the nightly sky with great precision, revealing them to be governed by the universal laws of nature. But how can change be described in a language that neither knows past, nor future tenses? The bright star that outshines all others after sunset in the evening sky is the "Evening Star," called Hesperus by the Ancient Greeks. His "brother," the star that appears before the sun rises in the morning sky is the "Morning Star," called Phosphorus by the Ancient Greeks. It was the great philosopher and scientist Pythagoras who recognized that Hesperus and Phosphorus are, in fact, not two different stars, but one and the same "star" instead, that is, the planet Venus. Some authors say that this was discovered earlier, by Babylonian astronomers. Either way, while the human observer perceives continuous changes in the sky, the coming and going of seemingly different stars, there is, in fact, no change. The observed phenomena reveal nothing but the "becoming visible" of one and the same, numerically identical planet at different times, in the East in the morning, and in the West in the evening. The planet Venus is the same at the present time as it was in the past, and it will remain the same in the future. It does not change. It moves in an orbit that likewise does not change and that, for this reason, can be described in the timeless language of mathematics. It is only from the vantage point of the human observer that change seems to occur: the

[4] http://www.bbc.co.uk/sn/tvradio/programmes/horizon/einstein_symphony_prog_summary.shtml (accessed 12/28/07).

"morning" star seems to come and go, as also does the "evening star." But this is merely apparent change in an unchanging world. Venus does not change, nor does the orbit along which it moves. This world, which some interpreters trace back to Aristotle amongst Ancient Greek philosophers[5], is one of the dynamic permanence: the observable movements, the changes, the dynamics that seem to permeate the observable world are ultimately reducible to the unchanging, that is, static and fundamental structure of the universe, governed by timeless, universal laws that can be expressed in the equally timeless, universal language of mathematics. To sketch a world of dynamic permanence represents an attempt to identify a unified and unchanging "being" that underlies the continuous "becoming" of an ever changing multiplicity of phenomena.[6]

The ancient Greek philosopher Aristotle is famously known as the "father of biology," but also as one of the founders of formal logic. Could it be possible, or even meaningful, to describe the development of a chicken embryo in the language of formal logic? Aristotle, like many philosophers before – and after – him, struggled with the "Problem of Change," and the paradox it creates. How can something change, and while changing, how does it still remain one and the same "something"? Change implies the existence of an object that undergoes changes in its properties. And yet, all the while it changes, this object must remain the same, numerically identical object if it is to be the case that it is *this* object that undergoes change. The prominent twentieth century philosopher of science, Sir Karl R. Popper concluded: "every change is the transition of a thing into something with, in a way, opposite qualities."[7] The problem of change leads us into a paradox again. Consider an acorn that develops and grows into an oak tree: the descriptions of the acorn and of the oak tree are vastly different, and yet they apparently apply to one and the same individual organism. Or look at the caterpillar that transforms itself into a pupa from which a butterfly eventually emerges: is it possible to say that the caterpillar and the butterfly is one and the same, self-identical thing? And if it is, how are we going to express this in the language of logic? Ancient Greek philosophers are known for their love of paradoxes. Here is one, the famous ship owned by Thales of Miletus: constantly exposed to wind, weather, and waves, one plank after another is removed from it as necessary, and replaced with a new one. Intuitively, it seems right to call it the same ship, that is, the ship of Thales, even if after several years all of its original planks had been gradually replaced by new ones. But now consider a mischievous philosopher who takes away one plank after another, and slowly, again over several years' time, replaces the removed planks with new ones. But as he continues his repair work, he secretly stores the removed planks in a hidden place, and at the time when all the planks of the ship he started out with have

[5]Balss, H. 1943. Aristoteles biologische Schriften. Ernst Heimeran, Munich.

[6]Uhlmann, E. 1923. Entwicklungsgedanke und Artbegriff in ihrer geschichtlichen Entstehung und sachlichen Beziehung. G. Fischer, Jena, p. 14.

[7]Popper, K.R. 1989. Conjectures and Refutations. Routledge & Kegan Paul, London, p. 144f.

been replaced, he rebuilds from the planks he had squirreled away the original ship. We now have two identical ships – which one is Thales' ship?

One way to deal with paradoxes is through logical analysis, so let us look at the "problem of change" from a logical point of view. Given the appropriate axioms, mathematical theorems are considered to be universally true. Simply put, it is inconceivable that there would have been a time in the past, or that there would be a time in the future, at which "3 + 3 = 6" is false, whereas "6 – 3 = 5" would be true. Mathematical journals that are published in China and America use the same formal language to express the mathematical relations. The same is true for the language of logic, which again is timeless and universal. Just as there are timeless truths in mathematics, so there are timeless truths in logic, which can be formulated in terms of universal laws of logic.

One such basic law of logic is the law of noncontradiction: it says of two contradictory propositions that it is impossible for both of them to be true. Only one of those propositions can possibly be true; one must necessarily be false. But now consider the following proposition:

"This apple is all-over green *and* this very self-same apple is all-over red."

If the apple is all over-red, then it is not all-over green. So we can reformulate:

"This apple is all-over green *and* this very self-same apple is not all-over green."

But this, according to the law of noncontradiction, is false. One and the same, self-identical apple cannot be all-over green *and* all over-red. Of course, we could say that yes, one and the same apple cannot be all-over green and all-over read *at the same time*, but that one and the same apple can turn from being all-over green to being all-over read *through time*, that is, as it ripens. But the law of noncontradiction cannot accommodate change through time; there is no temporal dimension to that law. It is true that "being all-over green" is a property of an apple, as is "being all-over red", such that it might seem possible to anchor these properties in time: one and the same apple is all-over green in early summer, all-over red in the fall. But that argument avoids, rather than solves the problem of change, for the apple no longer undergoes genuine change. It just comes to relate to different properties at different times, a view of things bound to create metaphysical nightmares.[8] To overcome the problem of change, the Greek philosopher Parmenides concluded that there simply cannot be any real, genuine change.[9]

2.3 The Distinction of Essential and Accidental Properties

Aristotle saw things a little bit differently. When we say that it is one and the same apple that changes from being green to being red over time, then to "be green", or to "be red", cannot be properties in which to anchor the self-identity of that changing

[8]Heil, J. 2005. From an Ontological Point of View. Oxford University Press, Oxford.

[9]Mortensen Ch. Change. The Stanford Encyclopedia of Philosophy (Winter 2006 Edition), Edward N. Zalta (ed.), URL = http://plato.stanford.edu/archives/win2006/entries/change/.

apple. There must be something else, something other than its color, which establishes the self-identity of the apple through time and change. Aristotle tackled the problem of change by introducing a number of basic distinctions. First, he distinguished between material objects that extend through space, and properties that are not substantial but that are exemplified by objects. The apple is a substantial object that exists in time and space: we can pick it up and look at it from all sides before throwing it away or eating it. The properties of "being green" or "being red" are not substantial, but instead are exemplified by the apple at different times. We cannot pick up "being green", nor can we kick away "being red." Among properties, Aristotle further distinguished essential, permanent, unchanging properties from accidental ones, that is, properties that an object can gain or lose over time. An essential property is one that any object cannot fail to exemplify under any circumstances in which the object exists. An accidental property is one that an object can shed or acquire. Venus appears to be subject to constant change as it appears and disappears in the morning sky and in the evening sky. Such changing properties, that is, "appearing in the morning sky," and then again "appearing in the evening sky," must be accidental properties of Venus. But these observable changes that Venus undergoes reoccur with remarkable regularity, one that can be precisely calculated. The reason is that Venus orbits the Sun (to the Ancient Greek, it seemed to orbit the earth) along a unique yet immutable trajectory. To travel on this never changing trajectory is an essential property of Venus. For Aristotle, the self-identity of a substantial object through time and change was grounded in its essential properties, that is, in properties that are permanent and that cannot change.

If the apple changes from being green to being red over time, then these colors cannot be essential properties of the apple. These must be accidental properties of the apple, instead. There must, therefore, be some other, essential, property that belongs to the apple and thus allows us to claim that it is the very self-same apple that changed from green to red. This property is the numerical identity of the apple that undergoes change: it is the numerically identical object that is once green, later red. If a caterpillar turns into a butterfly, and if both are said to be one and the same organism, then both the caterpillar and the butterfly must share some property that did not change during metamorphosis, and this property would be the essential property of that organism, establishing its numerical identity through change. The colors of the caterpillar or of the wings of the butterfly are accidental properties of those organisms, ones that apparently can undergo change. So what would be the unchanging essential property shared by the caterpillar and the butterfly that develops from it? It is the unique origin of that individual organism from one-particular fertilized egg that establishes its numerical identity. The same holds for the apple that changes from green to red: it is its origin from one unique fertilized flower that establishes its numerical identity. In an evolving world, a species can undergo change while remaining the same species. Its numerical identity through time and space is anchored in its unique evolutionary origin. In an evolving world, an ancestral species lineage can split into two descendant species lineages. Making two out of one means that an ancestral species gave rise to two numerically different descendant species. The same cannot be possible in a created world, for

in such a world, there is no unique evolutionary origin for a species, as there also is no origin of two new species from an ancestral one. In a created world, it is the unique act of creation of a species that anchors its identity through generations. Offspring differ from their parents in many ways, but all these differences could only be accidental differences. In a created world, the species, to which both parents and offspring belong, cannot undergo any essential change. The extinct mammoths look different from the living elephants. One could imagine that mammoths changed over time to give rise to the living elephants. But in a created world, the change from a mammoth to an elephant could only be apparent change, a change in accidental properties that was preconceived in the blueprint of Creation. If the elephant lineage is genealogically connected to the mammoth lineage, they must both belong to the same species, created at the beginning of time. They would have to share some underlying essential property, not visible to the human observer, which preserved the self-identity of the species through time and change, and that property would be the initial creation of the mammoth–elephant lineage.

A process that brings about change is composed of a series of events that stretches through time. For Aristotle, an event of change occurs if one and the same substance exemplifies one accidental property at one time or during one period of time; another accidental property at another time or during another period of time. Venus travels along an orbit that remains essentially unchanged, but becomes visible at different times at different horizons. That way, Aristotle obtained a world of dynamic permanence: everything is in motion, everything is changing all the time, but behind that apparent change lies the permanence, the timeless uniformity of nature, governed by timeless and uniform Laws of Nature that fix the orbit of Venus.

2.4 Embryos and the Problem of Change in Organisms

It is, perhaps, easy to comprehend that planets circle the sun on eternal orbits that are determined by timeless and universal laws of nature. However, it is less easy to comprehend how organisms that are born, develop, grow, and eventually die and decay would likewise circle through a world of dynamic permanence that is governed by universal laws of nature. But this is none-the-less the way early biologists understood the nature of species before evolutionary theory changed biology: the acorn grows into an oak tree, and the fertilized chicken egg develops into a chicken. These are processes of apparent change. But the oak tree species (e.g., the species *Quercus alba*), or the chicken species (e.g., the species *Gallus gallus*), do not change. They remain the same, forever. With a book published in 1651, William Harvey[10] – otherwise known as the discoverer of blood

[10]Harvey, W. 1651 [1981]. Disputations Touching on the Generation of Animals. Translated with Introduction and Notes by G. Whitteridge. Blackwell, London.

circulation – followed up on Aristotle's studies by opening chicken eggs to watch the embryo develop. Initially, there seemed to be a sort of a white, milky streak on the surface of the yolk, in the midst of which would gradually appear a little red, pulsating dot that became known as the "salient point" (*punctum saliens*) – the heart. From it would grow red filaments – the first rudiments of the blood-vascular system. Folding of tissues would later become observable – the chicken embryo starting to look like a maggot. Still later, head, trunk, and tail would become discernable. Tiny limb buds would eventually grow out of the trunk, and so on. The same process unfolded in a seemingly identical way in all the chicken eggs that Harvey examined, a regularity that suggests the developmental process to be governed by universal laws of nature. During its development, the embryo shows a number of changes of properties in terms of its size, shape, and composition – but could there be real change involved? Or are these just changes in accidental properties, and if so, what are the essential properties of animals and the species to which they belong? Harvey thought that the immutable, essential property of the developing chicken is its soul. It is this immortal soul that guides the development of the chicken to its species-specific goal according to a purpose, and this purpose is to perpetuate the species and its perfect adaptation to the place in the household of nature to which it has been assigned by its Creator. Modern biologists might be tempted to say that the essential, immutable property of the developing chicken is its genotype, but the analogy is misplaced. Genetics teaches us that the genome changes in the course of sexual reproduction, as the genes of both parents get mixed up and recombined in the genotype of the offspring. This is, after all, the stuff of evolution, a process that knows no goal or purpose. The soul, in contrast, is an essential property of the developing chicken that never changes. It is eternal and immortal. For Harvey, the soul was the guiding principle of embryonic development: it guided the development of the chicken in a purposeful way toward a well-defined goal: the persistence of its species through replication. The embryo seems to change during its development, but the species to which it belongs never changes. It is like the Morning Star and the Evening Star coming and going, while Venus remains immutably fixed on its orbit. Chickens develop, hatch, mature, reproduce, age, and die – they come and go. But the species remains the same, perfectly fulfilling the role assigned to it in the Plan of Creation. So what looks like change on the surface is not a real, essential change after all; it is only a change in temporary appearance, change in accidental properties. The fundamental structure of the universe remains the same, always, and forever.

But should the heart and the blood, the brain and the nerves that successively appear during its development really be considered as mere accidental properties of the developing chicken? Accidental properties can change: the heart of a fish has two chambers, while that of a chicken has four chambers. The brain of a fish looks very different from the brain of a chicken. But according to Harvey, the soul of a fish larva makes sure that it develops according to the blueprint that defines its species, just as the soul of the chicken guarantees the immutability of the blueprint that defines its species. A four-chambered heart looks more sophisticated than, and hence superior to a two-chambered heart, but there is no implication that one

changed into the other. They remain the same, forever, representing different rungs in the ladder of life, different steps in the Great Chain of Being. The early chicken embryo seemed at some stage of its development to resemble a maggot, the latter representing a much lower rung in the ladder of life than a bird. At its first appearance, the heart of the chicken is a simple pulsating vesicle, simpler yet than the two-chambered heart of a grown fish. So during its development, according to Harvey, the chicken embryo seemed to climb up the steps of the Great Chain of Being. But that, to him, was no evidence of essential change, and no evidence of progressive development. Instead, the development of the chicken merely expressed the same great Plan of Creation over again: the same hierarchical order that characterizes the Great Chain of Being also characterizes the embryonic development of the chicken. Harvey found embryonic development to run parallel to the Great Chain of Being, but the parallelism is one of a static order, not one of dynamic change. Later authors recognized that fishes with their two-chambered heart were put into space and time at a different epoch of earth history than birds with their four-chambered heart. But that for them again would not imply species change. The species remain the same, designed according to the blueprint of Creation. They just become apparent at different times and in different places in a succession that mirrors the Great Chain of Being once again.

And yet, it is easy to say that an apple undergoes accidental change as it changes from being green to being red. Such a change of color in an apple does not map on the changes that occur during the development of a chicken. The apple merely changes in color. In contrast, parts of the organisms seem to come into existence during the development of a chicken that had not been there before. There was no sign of a heart before the appearance of the little red, pulsating dot. There was no sign of a brain before the folding of tissues that resulted in the formation of a head, trunk, and tail. Genuine change seemed indeed to occur in the development of a chicken. There is not merely a persisting substantial object that changes its colors or other accidental properties. Instead, there are new substantial parts of an organism, a heart, a brain, which seem to come into being. It is for such reasons that Harvey's 1651 account of embryonic development left some fellow biologists unconvinced or at least unsatisfied. The heart made its appearance early during development, but where did it come from? The vesicles that would form the brain appeared after the pulsating little red dot, but where was the brain before it started to become apparent? Many biologists and philosophers of the seventeenth and eighteenth century looked back on Aurelius Augustinus, known today as St. Augustine, for a solution,[11] for he, in the fifth century, famously dealt with another paradox of change, which was the resurrection of Christ into the realm of Deity. Being born from a human, and suffering death, Christ assumed a divine nature through His resurrection. How could this be possible, given that His divinity is an essential property of Christ, a property that transcends space and time, one that is eternal and

[11]Roger, J. 1971 Les Sciences de la Vie dans la Pensée Française du XVIIIe Siècle, 2nd ed. Armand Collin, Paris.

immutable? An eternal property cannot come into being at a certain location in space and at a certain point in time, for if it did, then it would not be eternal. To solve the paradox, Aurelius Augustinus invoked his famous doctrine of preexistence. Just as the oak tree preexists in the acorn, he said, so did divinity preexist in Christ, but it became actualized only upon His death and resurrection. Taking their clues from Augustine, biologists set out to develop perplexingly complex models of animal reproduction to avoid the paradoxical problem of change. The essential property of an animal species was rooted in its initial Creation at the beginning of time: its essence maintains the perfect adaptation of the species to the particular place in the household of nature to which it had been assigned by the Creator. If embryonic development of an organism seemed to string together a sequence of profound changes, this could only amount to a mistaken impression that resulted from the imperfect powers of human perception. Instead, development was explained as nothing more than a mere process of unfolding, a process through which preexistent structures became actualized, that is, functional. Augustine had claimed that the oak tree preexists, in its entirety but folded up and thereby reduced to miniature size, within the acorn.[12] As it develops and grows, it does not undergo any genuine change. Its growth, its development, is merely an unfolding and becoming apparent of what already exists. The wings of a butterfly preexist inside the caterpillar. They do not develop from rudiments, but merely unfold, as the butterfly emerges from the pupa. The world of biology is thus fully brought back into dynamic permanence: no real change would ever take place; what might appear as change to the human observer was merely the unfolding, the "becoming visible" of preexisting structures that had existed, encapsulated within one another, since the initial act of Creation at the beginning of time.

Antony van Leeuwenhoek was a Dutchman, who built the first microscopes, thus obtaining the means to observe things never seen by anyone before. His lenses drew a strange, vast, and varied microcosm close enough to be studied in detail. He communicated his discoveries to the Royal Society of London in a series of letters, which were then published in the prestigious "Philosophical Transactions" – the world's oldest scientific journal, which is still in existence.[13] In a letter drafted in 1677[14], for the first time in the history of biology, he described male spermatozoans that he had obtained from animals such as sturgeons and dogs. He believed that these little wiggly organisms carry the encapsulated, preexistent embryo into the female egg upon fertilization. The female egg would provide nothing more but the nutritive environment required for the development of the embryo, which would be the mere unfolding of the preexistent structures. Since the spermatozoon was able to propel itself forward with its tail, it had to be an animated animalcule, which is

[12]Augustinus, A. 1961. De Genesi ad Litteram Libri Doudecim. Translated by J.C. Perl. Ferdinand Schöningh, Paderborn.

[13]http://rstl.royalsocietypublishing.org/

[14]Leeuwenhoek, A. 1677. Observationes D. Anthonii Lewenhoeck, De Natis E Semine Genitali Animalculis. Philosophical Transactions of the Royal Society of London, 12: 1040–1046.

endowed with an animal soul. Since Leeuwenhoek believed the preexistent embryo to be encapsulated within the head portion of the spermatozoon, the latter also carried the soul of the embryo. He reported that huge numbers of spermatozoans are found in the seminal fluid of male sturgeons, dogs, and humans, and in the fact that only a tiny minority of those would likely go on to successfully fertilize an egg, many critics located a theological problem.[15] According to Leeuwenhoek's calculations, a huge number of souls would go to waste, something that was irreconcilable with the thinking of the time. In his "*Essay de Dioptrique*" of 1694, Nicolaas Hartsoeker claimed he had first observed spermatozoans "more than twenty years ago," thereby claiming priority in their discovery[16], a claim that turned out to be unsubstantiated, upon historical analysis.[17] However, Hartsoeker did publish the famous figure that shows a miniature homunculus fully preformed but folded up to a very small size in the head portion of a spermatozoan.

The same doctrine, called animalculism, was adopted by the great German philosopher, Gottfried Wilhelm Leibniz, who in his *Theodicy* of 1710[18] used it to establish the permanence of the relation between the body and the soul through death and resurrection. The development of the organism was a simple process of growth, a mere unfolding of structures that already preexisted; nothing new comes into being; development merely renders visible what already existed from the beginning of time. According to Leibniz, when the organism dies, it is folding up again to the dimensions of a physical point, too small for us to see. Resurrection is simply the reinitiation of the same process of unfolding. The attractive aspect of this theory is that the soul never needs to be stipulated to exist in separation from the body to which it belongs, something Leibniz believed to be impossible. Accordingly, the essence of each individual is its soul, and the changes an individual undergoes during development and ageing are changes in accidental attributes. But even these do not really change: what looks like change is merely the unfolding of preformed and preexisting structures.

However, some authors spotted troubles with Leibniz' theory. Leibniz had proclaimed that if an ordinary man falls asleep and suddenly wakes up again to find himself transformed to be the Emperor of China, he would have to remember his former life to appreciate the benevolence of God, who overnight transformed him to take up such a privileged position. Similarly, one would have to remember one's life to be able to appreciate God's benevolence at one's Last Judgment. But now consider the pious soldier who, through an unfortunate accident, is decapitated in battle. He dies and contracts to an invisibly small physical point. As he unfolds upon his resurrection, his body will be missing its head, and with it the brain (the seat of the soul), and with it the memory of his

[15]See discussion in Roger, 1971, ibid., esp. pp. 317ff. See also Hankins, T.L. Science and the Enlightenment. Cambridge University Press, Cambridge, UK, p. 135.

[16]Hartsoeker, N. 1694. Essay de Dioptrique. Jean Anisson, Imprimerie Royale, Paris, p. 222

[17]Roger, 1971, ibid., pp. 299ff.

[18]Leibniz, G.W. 1710. Essais de Théodicée. Isaak Troyrl, Amsterdam.

former life. The poor man would be called to his Last Judgment without the capability to comprehend the verdict.

2.5 Charles Bonnet and His Understanding of Evolution

The eighteenth century biologist and philosopher Charles Bonnet[19] from Geneva resisted his father's wishes for him to become a Lawyer, and instead took an early interest in insect life. Pursuing these interests, he discovered that captive female aphids, also known as plant lice, could produce viable and fertile offspring without ever having had any contact with the opposite sex. He separated aphids from the moment of their birth, keeping them in different powder jars. After just a few days, he found to his surprise that the isolated lice had multiplied. Charles Bonnet thus made history of biology with his discovery of parthenogenesis, the fertile reproduction by females of bisexual organisms without insemination by males.[20] For Bonnet, this discovery confirmed his friend Albrecht von Haller's conclusion that embryos were not preexistent in the male spermatozoans, but in the female egg instead.[21] It is the egg that contains the embryo, preformed, and preexistent in all its parts and ready to unfold, once the spermatozoon fertilizing the egg triggered that developmental process. In his native language, which was French, Bonnet called the process of the unfolding of preexistent embryos "*une évolution*." This is the original meaning of the term "evolution."[22] The female of the first pair of each species created at the beginning of time would contain within itself eggs that encapsulated the germs of the next generation. Amongst the latter, the female germs contained the eggs that encapsulated the preexistent organisms of the next generation and so on – as far as the Creator had planned the natural course of events to unfold.[23] No change ever takes place, nothing new ever develops: nature works as small as is necessary to accommodate Divine thought. On Bonnet's account, the history of a species through time compares with the unpacking of a set of Russian nesting dolls. By the time of Bonnet's writing, it had been well-established that the surface of the earth had undergone dramatic changes through geological time. It had also become apparent that organisms preserved as fossils in successive layers of sedimentary rocks document the successive appearance and later disappearance of different species as one climbed up the quarry wall, breaking the rock with a

[19]Rieppel, O. 2001. Charles Bonnet (1720–1793), pp. 51–78. In: Jahn, J., and M. Schmitt (Eds.), Darwin & Co., Vol. 1. C.H. Beck, München.

[20]Bonnet, Ch. 1745. Traîté d'Insectologie. Première Partie. Durand Librairie, Paris.

[21]Haller, A. 1758. Sur la Formation du Coeur dans le Poulet; sur l'Oeil; sur la Structure du Jaune & c. Premier Mémoire. Marc-Michel Bousquet, Lausanne.

[22]Bowler, P.J. 1975. The changing meaning of evolution. Journal of the History of Ideas, 36: 95–114.

[23]Bonnet, Ch. 1768. Considérations sur les Corps Organisés, 2nd Ed. Marc-Michel Rey, Amsterdam.

hammer. All of this reduced in Bonnet's eyes to the unfolding of preexisting structures encapsulated within one another, according to the Plan of Creation. The unfolding of life on earth, the coming and going of different species in the Fossil Record, compared with a set of Russian nesting dolls where an encapsulated doll can differ, in preconceived and predetermined ways, from the encapsulating doll, so as to perfectly match the environmental conditions of the geological era into which it was born. Bonnet cited the writings of an Englishman, William Whiston's "*A New Theory of the Earth*" published in 1696[24], and praised by such scientific luminaries as Newton to whom the work was dedicated, when he claimed that the earth underwent a series of catastrophes during its past history, of which the deluge was one, but not the only one. More such catastrophic events were to occur in the future, as was announced in the Holy Bible. Such catastrophic events, marked by the stratigraphic boundaries between the successive layers of sedimentary rock, would wipe out the then existing forms of life. But these harbor in their brain a germ of resurrection, which in turn encapsulates the preformed and preexistent string of generations that would stretch out to the next global catastrophe, which would in turn set free a new set of encapsulated germs of resurrection, which would start a new process of unfolding in a changed world. Following the next global catastrophe, humans might be resurrected as inhabitants of the realm of angels, whereas apes might take the place of worldly humans, according to Bonnet.[25] However, from the beginning of time to the eventual apocalypse of the world, no real change ever took place, nothing new ever developed. All life at any period of earth history was merely the product of growth and unfolding of what already existed. The Creator and nature, according to His plan, work as small as they have to make this possible. To doubt this world-view is to doubt the almightiness of God. Bonnet adopted this doctrine, called ovulism, not only on the basis of his discovery of parthenogenesis, but also primarily as a consequence of the research by Albrecht von Haller, who again had published on the development of chicken in 1758.[14]

Haller was an eminent medical researcher at the University of Göttingen, before returning to his hometown Berne in Switzerland, assuming the role of secretary to the city parliament.[26] Haller had found that the membrane surrounding the yolk in the chicken egg remains in unbroken continuity with the intestinal tissue of the developing chicken throughout its development. The developing chicken must therefore preexist in the egg, not in the sperm, and it had to be preformed in its entirety, with all its parts, for functional reasons. A developing organism cannot be assembled from parts like a machine. If Harvey believed that the heart developed, and hence existed, before its associated vessels, or also before the head and the brain contained within it, he must simply have been wrong. He must have missed parts of the embryo during early stages of its development, because these are perhaps too

[24]Whiston, W. 1696. A New Theory of the Earth, From its Original, to the Consumation of all Things. R. Roberts for Benj. Tooke, London.

[25]Bonnet, Ch. 1769. La Palingénésie Philosophique, Vol. 1. C. Philibert and B. Chirol, Geneva.

[26]Balmer, H. 1977. Albrecht von Haller. Paul Haupt, Berne.

small to be seen, or else they are fluid in nature, transparent and hence elusive like the bones. Haller described how bones first appear as soft, transparent, and gelatinous structures, and only successively reveal themselves to observation as more and more "earthy substance" is deposited into them (bones of the internal skeleton are preformed in translucent cartilage before they ossify). All parts of the developing embryo must exist from the beginning of its development, for development means the unfolding of preexisting structures through growth. But above all, growth requires nutrition. The distribution of nutritive material to the unfolding organs requires a transport system, which is the blood-vascular system. However, the blood-vascular system cannot fulfill its role without a pump, which is the heart. In turn, the proper functioning of the heart muscle depends on its proper stimulation through the nerves that innervate it. The nerves, in turn, originate from the brain, and so on. The adoption of the doctrine of preexistence was not only motivated by the desire to avoid the paradox of change but it was also was rooted in empirical observation and in physiological theory construction, which led to the doctrine of the functional correlation of parts in a living organism. On August 11, 1770, Bonnet wrote to his friend Haller: "The animal is evidently a *whole* the parts of which must always have *coexisted*. The heart presupposes the arterial system; the latter presupposes the venous system, etc… It suffices to show you a foot, or a hand, for you to be able to fathom the whole… The whole universe is a giant machine, of which no part whatsoever could have existed in isolation from all others."[27] The proper functioning of an organism as a whole required the harmonious functioning of all its interdependent parts. The parts of an organism could not be assembled piece-meal during the process of development, nor could those parts be dissociated. Either was believed to disrupt the harmony of the functioning whole and with it the perfect adaptation of the organism to the place in the household of nature to which its species had been assigned by the Creator.

The organism was seen as perfect clockwork, which is designed and constructed according to the blueprint of Creation. This design assured the perfect adaptation of the species to its specific environment. The clockwork cannot function properly if it is assembled piece-meal from its parts until such time as all parts have perfectly been fitted together, and the same would be true for organisms. However, the organism does have to function from the first day of its development. Its parts, therefore, cannot be successively put together by development. All parts of the developing organism must coexist and function together to make development possible in the first place. But then, nothing new ever develops, no change ever takes place. Species consequently cannot change, or so it was believed.

Not just the organism, the entire universe was seen as such a perfectly designed clockwork. The organism was the microcosm that mirrors the macrocosm. The unfolding of the developing embryo mirrors the Great Chain of Being, as both are subject to the same principle of order that puts the complex above the simple. Such was the Plan of Creation, captured by the doctrine of preexistence. Coupled with the

[27]Sonntag, 1983, ibid., p. 890.

doctrine of encapsulation, the doctrine of preexistence reduced the change observable in the developing embryo to mere appearance, to the mere actualization or unfolding of what already exists. This was an eighteenth century edifice of French biology that was well aligned with religion and politics, with the ideals of people with wealth and power. Although avoiding the paradox of change, the doctrine of preexistence itself created paradoxes of a different kind, that is, of a biological kind that would ultimately result in its demise. If they were preformed and preexistent in the mother's eggs from the beginning of time, why is it that children not only perpetuate the species *Homo sapiens*, but also beyond that show mixed resemblances to both parents? And why would siblings show different combinations of such parental characteristics? Worse: why would a benevolent Creator preform disadvantaged children handicapped by various malformations before these children were born into the world?