

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

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

¹Whitehead, 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.

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

³For 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

⁴http://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 philosophers⁵, 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

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

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

⁷Popper, 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 red *at the same time*, but that one and the same apple can turn from being all-over green to being all-over red *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

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

⁹Mortensen 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 Harvey¹⁰ – otherwise known as the discoverer of blood

¹⁰Harvey, 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

¹¹Roger, 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 1677¹⁴, 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

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

¹³<http://rstl.royalsocietypublishing.org/>

¹⁴Leeuwenhoek, 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 discovery¹⁶, 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 spermatozoon.

The same doctrine, called animalculism, was adopted by the great German philosopher, Gottfried Wilhelm Leibniz, who in his *Theodicy* of 1710¹⁸ 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

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

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

¹⁷Roger, 1971, *ibid.*, pp. 299ff.

¹⁸Leibniz, 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 Bonnet¹⁹ 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

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

²⁰Bonnet, Ch. 1745. Traité d'Insectologie. Première Partie. Durand Librairie, Paris.

²¹Haller, 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.

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

²³Bonnet, 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 1696²⁴, 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

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

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

²⁶Balmer, H. 1777. *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 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

²⁷Sonntag, 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?

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Rieppel, O.

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