From Logos to Bios: Hellenic Philosophy and Evolutionary Biology

by

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Summary:

This thesis deals with the relation of Hellenic philosophy to evolutionary biology. The first part entails an explication of Hellenic cosmology and metaphysics in its traditional understanding, as the Western component of classical Indo-European philosophy. It includes an overview of the relevant contributions by the Presocratics, Plato, Aristotle, and the Neoplatonists, focussing on the structure and origin of both the intelligible and sensible worlds. Salient aspects thereof are the movement from the transcendent Principle into the realm of Manifestation by means of the interaction between Essence and Substance; the role of the Logos, being the equivalent of Plato's Demiurge and Aristotle's Prime Mover, in the cosmogonic process; the interaction between Intellect and Necessity in the formation of the cosmos; the various kinds of causality contributing to the establishment of physical reality; and the priority of being over becoming, which in the case of living organisms entails the primacy of soul over body. The first part of the thesis concludes with a discussion of the implications of Hellenic cosmology and metaphysics for evolutionary biology, including an affirmation of final and formal causality over and against its rejection by the modern scientific project. The second part commences with a delineation of organic form and transformation, emphasising the mathematical foundations thereof. It continues with a critical consideration of the modern evolutionary theory on both scientific and philosophical grounds. In the process a fundamental distinction is made between micro- and macro-evolution, involving the reshuffling of existing genetic material which is acted upon by natural selection, and the production of new genetic material by means of macro-mutations, respectively. In the remainder of the thesis the macro-evolutionary process is described as mainly lawful, directed and convergent, instead of contingent, undirected and divergent as postulated in the modern evolutionary synthesis. This approach does not preclude the recognition of exceptions, due to the limitation of Intellect by Necessity – that is to say, of teleology by mechanism.

Key terms: Cosmology; Logos; Demiurge; Substance; Causality; Teleology; Intellect; Soul; Form; Matter; Transformation; Evolution; Nomogenesis; Orthogenesis; Convergence

Contents

1: Introduction

In this thesis we endeavour to demonstrate the relevance of Hellenic philosophy for evolutionary biology. The evolution of life on Earth has been one of the most contentious issues in the natural sciences and beyond ever since the publication of Charles Darwin's theory of organic descent by means of natural selection in 1859. Since the rise of the so-called Neo-Darwinian synthesis during the second quarter of the twentieth century, the resultant tradition popularly known as 'Darwinism' has become firmly established as biological component of the modern scientific paradigm. The latter was founded in the seventeenth century by Galileo, Descartes, Bacon and others, and has ever since rested upon the twin pillars of materialism and mechanism, in terms of which everything can be explained in terms of quantitative laws (Nasr 1981: 49). Due to this 'scientific revolution' an ever-increasing number of people in the Western world came to view the natural sciences as a more reliable source of knowledge than the revelations of religion or the deductions of philosophers. This in turn led to the rise of a naturalistic world-view, in terms of which the universe was entirely due to the operation of autonomous natural laws (Swift 2002: 391-392). By the nineteenth century the traditional notion of a Great Chain of Being (based mostly on the philosophy of Plato and Aristotle), according to which all levels of reality are related in a cosmic hierarchy with God at the summit, had become horizontalised and temporalised (Nasr 1981: 49-50). This ontological deprivation, as it were, provided the opportunity for Darwin to propose a theory of evolution as the best explanation of biodiversity outside of Divine creation, which he had come to reject. However, Darwin's theory soon became a dogma in order to replace religious faith among those who have discarded God, which is how the Darwinian theory of evolution has survived to this day – in the words of Seyyed Hossein Nasr, as 'a convenient philosophical and rationalistic scheme to enable man to create the illusion of a purely closed Universe around himself' (1981: 50).

It is our intention to make a contribution towards a more lucid understanding of biological evolution through a two-fold methodology: first, by an explication of Hellenic cosmology and metaphysics in its traditional understanding, over and against its distortion in modern academic circles (such as the presentation of the Presocratics as naïve speculators or proto-materialists, of Aristotle as an anti-Platonist, and of the Neoplatonists as religious extremists);

and second, by drawing out relevant aspects of Hellenic cosmology and metaphysics for evolutionary theory. Our hermeneutical approach accordingly entails an interpretation of Darwinism in the light of Hellenism. In other words, our thesis comprises a hermeneutical dialogue between two contrasting traditions. It is presented as a challenge to the absolutist claims of the secular world-view of our time, including Darwinism.

The relevance of Hellenic thought for the theory of evolution pivots around its potential of providing an illuminating alternative to the hackneyed dichotomy that from the outset has dominated the ongoing debate concerning the origins of biodiversity. On the one hand are those who reject any notion of organic evolution on supposedly religious grounds, and on the other hand those who support even the most materialistic and mechanistic notions of evolution. We concur with Alfred North Whitehead that the apparent conflict between ‘science’ and ‘religion’ is attributable to the deficiencies of both scientific materialism and super-naturalistic theism, respectively (Griffin 2006: 454-455). In contrast to both of these positions, associated in popular scientific literature with atheistic scientists and religious fundamentalists, respectively, stands Hellenism with its comprehensive integration of the metaphysical and the physical. In this way Hellenic philosophy avoids the conceptual version of Scylla and Charybdis, of having to choose between the twin errors of atheistic materialism and religious supernaturalism.

We will argue that the modern evolutionary theory is both metaphysically implausible due to its rejection of formal and final causality, and on the empirical level is unable to satisfactorily explain the phenomenon of macro-evolution (i.e. the arising of new phyla, classes, orders, families and probably genera, as well as complex organic structures such as the brain, eye, or feather). In contrast to micro-evolution (i.e. the arising of variations within a species and of species within a genus) which occurs due to the separation and recombination of existing genetic material, macro-evolution requires the production of new genetic material. Such genetic novelty results from a macro-mutational jump, as it were, which in turn produces major morphological changes. It will be argued that the macro-evolutionary process is characterised by lawfulness, direction, and convergence – thus conforming to the Hellenic metaphysical principles of formal and final causality.

In the introductory chapter the Indo-European background to our thesis is sketched, since it provides a crucially important hermeneutic key for the understanding of Classical thought. It delineates relevant aspects of Indian and Hellenic philosophy, such as the interaction between Essence (*Purusha*) and Substance (*Prakriti*) in the realm of Manifestation, and the metaphysical concept of evolution as the unfolding of inherent possibilities. Thereafter the thesis focuses on Hellenic philosophy as a specific manifestation of the Indo-European tradition, since it would be over-extending our scope to fully include Indian philosophy. Chapters on pertinent aspects of Presocratic, Platonic, Aristotelian and Neoplatonic philosophy are therefore presented, concluding with a discussion of the implications of this Hellenic spiritual-intellectual tradition for evolutionary biology. Prominent among these are the Logos doctrine of Heraclitus; the numerical cosmology of Pythagoras; the creative role of the Demiurge, and the interaction between Intellect and Necessity in Plato's cosmology; the fourfold causal scheme of Aristotle, which in the case of living things entails an interaction between soul and matter in order to attain a specific purpose; the Neoplatonic notion of indwelling reason-principles (*logoi*) throughout the manifested order; and the hierarchical, ontological scheme of an all-embracing Chain of Being linking the various levels of cosmic reality, including the organic realm.

The second part of the thesis is introduced by an outline of organic form and transformation, emphasising its mathematical foundations. This is followed by a brief outline of modern evolutionary theory, focusing on the contributions by Darwin, Dobzhansky and Gould, as well as a critical assessment thereof from scientific, philosophical, and metaphysical perspectives. In the next three chapters the macro-evolutionary process is presented as predominantly lawful instead of contingent, directed instead of random, and convergent instead of divergent, while allowing for the ubiquitous presence of exceptions – the latter being recognised by both Plato (as Intellect limited by Necessity) and Aristotle (as teleology limited by mechanism).

The conclusion attempts to draw together the domains of the philosophical (*logos*) and the biological (*bios*) in the light of the preceding arguments. It is presented as an invitation to further reflection and debate on this highly important question, namely the origins and mechanisms of organic diversity.

2: The Indo-European background

2.1 Introduction

A common origin has been ascribed to Indo-European humanity, dating back to its sojourn in the southern parts of the vast land known since medieval times as Russia (or, to be more precise, *Rus'* in Old East Slavic). This location of the *Urheimat* of the prehistoric Indo-Europeans has been demonstrated on the grounds of historical linguistics, archaeology, quantitative analysis and archaeogenetics (Quiles & López-Menchero 2012: 58-66). From their ancestral homeland the Indo-Europeans ventured forth in successive waves, first westwards into Europe from around 3000 B.C. and then southwards into the Near East and the Indian subcontinent from around 2000 B.C. The western branch of the Indo-Europeans developed into the Germanic, Slavic, Baltic, Celtic, Italic and Hellenic peoples (referred to collectively as the Nordic peoples; Campbell 1970: 9), while the eastern branch unfolded as the Indo-Aryans of Iran and India. An offshoot of the western branch migrated south between the Black Sea and the Caspian Sea, eventually settling in Asia Minor where they became known as the Hittites (King 2007: 28-33).

Due to these extensive migrations, the Proto-Indo-European language (abbreviated as PIE) developed into the numerous Indo-European languages spoken or studied today, of which Sanskrit, Greek and Latin are the most venerable ones. Juxtaposing the Kurgan Hypothesis in archaeology with the Three-Stage Theory in linguistics, the Spanish scholars Carlos Quiles and Fernando López-Menchero found that between around 3500 and 3000 B.C. the Late Indo-European language (LIE) became differentiated into at least two dialects, namely southern (or Graeco-Aryan) and northern. Between around 3000 and 2500 B.C. these dialectical communities began to migrate away from their *Urheimat*, so that the resultant Corded Ware cultures eventually extended from the Volga to the Rhine. Then, between around 2500 and 2000 B.C, when the Bronze Age reached Central Europe, the southern LIE dialect had differentiated into Proto-Greek and Proto-Indo-Iranian. The invention of the chariot enabled the rapid spread of the Indo-Iranians over much of Central Asia, Northern India and Iran during the next stage, dated between around 2000 and 1500 B.C. This stage also saw the break-up of Indo-Iranian into Indo-Aryan and Iranian, the differentiation of European proto-dialects from each other, and languages such as Hittite, Mitanni and Mycenean Greek being spoken or written down. By between around 1500 and 1000 B.C. the European proto-dialects had evolved into Germanic, Celtic, Italic, Baltic and Slavic, while Indo-Aryan became expressed in its sacred language Sanskrit, for instance in the composition of the *Rig-Veda*. Finally, with Northern Europe entering the Iron Age between around 1000 and 500 B.C, the Greek and Old Italic alphabets appear, and the Classical civilisation flowers among the Hellenic peoples (Quiles & López-Menchero 2012: 67, 75).

At an early stage, possibly before their migrations into Europe, the western branch of the Indo-Europeans became divided into northern and southern groups, called the Proto-Nordics and Proto-Mediterraneans respectively. The religious beliefs of both groups were apparently based on the worship of a benign Father-god, with whom it was possible to be reunited in the afterlife. This paternal God was evidently conceived in two different though related aspects: while the Proto-Mediterraneans worshipped a Sun-god whose symbol was the Sun, the Proto-Nordics worshipped a Sky-god whose symbol was the thunderbolt (Campbell 1970: 13-14). Regarding the former, it should be noted that in all probability it was not the physical Sun that was worshipped, but rather the Spirit who created the Sun with its heat and light. Among the ancient Accadians and Babylonians this Sun-god was called Bel, the memory of which has been preserved among some of the Celtic peoples in the annual fire-festival known as Beltane. Also among the Celts was found a Druidic prayer in which God was entreated to grant his supplicants the love of the right, the love of all things, and the love of God (Campbell 1970: 8-10) – evidence of high spirituality indeed. This Indo-European notion of a benign Divinity is also encountered in a prayer ascribed to Socrates: 'King Zeus, whether we pray or not, give us what is good for us; what is bad for us, give us not, however hard we pray for it' (*Second Alcibiades*, 143; Campbell 1970: 12).

The vast spiritual-intellectual tradition (Sanskrit *sanatana dharma*; Greek and Latin *sophia perennis*, 'eternal wisdom') of the Indo-Europeans has been expressed above all in classical Indian and Hellenic philosophy, the combination of which remains unsurpassed in the profundity of its thought and the brilliance of its exposition.[1] Contrary to the prevailing rationalistic paradigm in Western academic circles, it has to be emphasised that Indo-Hellenic thought is primarily rooted in spiritual experience. This metaphysical foundation applies also to scientific thought, as Oswald Spengler affirmed: 'There is no Natural science without a

1 Due to the universality of the divine Intellect, the *sophia perennis* is *ipso facto* not limited to the Indo-Europeans. The wisdom tradition is likewise encountered in Egyptian, Babylonian and Chinese philosophy, but these fall outside the scope of the present study.

precedent Religion' (1991: 190). In other words, the mystical vision (Greek *theōria*) of the Reality that underlies the world of empirical phenomena preceded the philosophising of the Vedantic, Presocratic and Platonic thinkers.[2] This Indo-European mystical vision of the One and all (Greek *hen kai pan*) found its earliest literary expression in the Upanishads and the works of early Hellenic thinkers such as Heraclitus and Parmenides (Günther 2013: 51). It is therefore not surprising that the Hellenic metaphysical tradition of Orphism, Pythagoras and Plato is similar to the mysticism of the Upanishads. In both traditions one encounters a shift of emphasis from the physical to the spiritual and from the temporal to the eternal. The salient dictum of this Indo-Hellenic mystical vision is the recognition that ultimate reality (Brahman, God, or the One) lies beyond sense perception (Marlow 1954: 39). That is to say, reality is not limited to the physical world, contrary to the claims by those who reject transcendent reality.

2.2 Indo-Hellenic parallels

As we noted above, the Greek and Indo-Aryan languages trace their origin to a common Graeco-Aryan dialect. And since thought is expressed pre-eminently in language, it is therefore not surprising that remarkable parallels exist between the Indian and Hellenic metaphysical traditions. In his informative 1954 study a number of these parallels have been pointed out by A.N. Marlow, beginning with the Presocratics:

(i) The earliest known Hellenic philosopher, Thales, viewed water as the fundamental principle (*archē*) out of which everything arise. This notion is echoed in the teaching of the *Rig Veda* (X.168, X.190) that water is the primary principle, which develops into the world. In the *Iliad* (XIV.201, 246) Homer stated a similar view in mytho-poetical language, namely that Ocean is the origin of all the gods (Marlow 1954: 36).

(ii) For Anaximander the first principle is the *apeiron*, which means the indeterminate or unlimited. This term is the equivalent of the Sanskrit *nirvikalpa*, the nameless and formless, which the Rig Veda calls *aditi*, the unlimited. Moreover, the *aditi* is ordered by the immanent *rita* (*Rig Veda* IV.23.9), in the same way as in Anaximander an immanent *dikē* ensures the eventual return of all things to the *apeiron* from which they arose (Marlow 1954: 37): 'The things that are perish into the things out of which they come to be, according to necessity, for they pay penalty and retribution to each other for their injustice in accordance with the

[2] The metaphysical mysticism of the Presocratics and Plato culminated in Aristotle's project to express spiritual-intellectual realities in terms of logical argumentation, with all the limitations this entails. However, it is erroneous to view Aristotle as an anti-Platonist and hence the precursor of modern rationalism and empiricism, as has become commonplace in academic circles, since Aristotle's philosophy of nature, including his biological work, is grounded in Platonic metaphysics (e.g. the priority of being over becoming and of form over matter), although he diverged from certain interpretations of the latter.

ordering of time' (Fragment 1).
(iii) Heraclitus shares two fundamental (and related) doctrines with early Buddhist schools: that fire is the primary element, and that all things are transitory and ephemeral (Marlow 1954: 37-38). The notion that fire is the primordial element also appears in the *Rig Veda* (I.67). For both the Buddha and Heraclitus, fire as the most mutable of the elements represents the metaphysical principle of becoming.[3] Thus in the *Mahavagga Sutta* the Buddha compares sentient existence with a candle flame which is renewed in every moment (i.121). In his turn Heraclitus wrote, 'No god or man ever created this world which is the same for all, but it was and is and ever will be everlasting fire' (Fragment 30). The Buddha also uses the analogy of a river, which is never the same for two successive moments but is rather sustained by ever-new waters (*Mahavagga* i.123). An identical terminology was employed by Heraclitus: 'Ever different is the water for those who step into the same rivers' (Fragment 91). In this way the teaching of Heraclitus on the transience of things reflects the Buddha's teaching of impermanence (*anicca*) and non-self (*anatta*) (Krüger 2007: 143). In addition, for the Buddha the fundamental principle of existence is the immutable law, or *dharma*, which decrees that every action earns its reward. Heraclitus held a similar view regarding the universal, immutable *logos* that regulates the cosmos: 'So we must follow the common principle, for that is shared by all' (Fragment 2), and 'For wisdom consists in one thing, to know the principle by which all things are steered through all things' (Fragment 41). Furthermore, Heraclitus' view that truth is to be found in the interaction between opposites anticipated the dialectic of Nagarjuna, founder of the Madhyamika school in Buddhism (Krüger 2007: 143).
(iv) Empedocles' theory of sense perception ('For by earth we perceive earth, by water water, by air divine air and by fire destructive fire', Fragment 109) resembles the epistemology of the Upanishads and Indian philosophy. For instance, in the *Samkhya* system the world as object of perception has five *tanmatras* (subtle elements), each of which is perceived by something corresponding to it within us (Marlow 1954: 39). A number of Buddhist elements are also reflected in the philosophy of Empedocles, such as the eternal return of all things and the distinction between illusion and true, mystical understanding (Krüger 2007: 143).

When one juxtaposes Indian philosophy with that of Plato the parallels are similarly striking (Marlow 1954: 41-45). One of Plato's most important contributions to Western philosophy

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[3] This coherence reinforces the view that the Presocratics did not conceive of their primary elements of water, air, fire, etc. in the material sense only, but above all as symbols of metaphysical reality (Schuon 1984: 71).

and theology is his notion that the soul (*psychē*) is ontologically prior the body, thus continuing the Pythagorean doctrine on the immortality of the soul. During its earthly existence the soul is imprisoned in the body (*sōma*), so that the latter is described as a tomb (*sēma*) in which the soul is kept until the penalty for its transgressions has been paid (*Phaedrus* 250c; *Cratylus* 400c; *Gorgias* 493a). It is interesting to note in this regard that *sēma* also means 'sign', and therefore the body could also be understood as the means whereby the soul indicates (*sēmainei*) its form and purpose. The body as tomb thus functions as an eclosure (*peribolos*), keeping the soul within its limits in order that it may be saved (Uzdavinys 2011: 94). Accordingly, for both Plato and the Brahmins philosophy is a meditation on death (Marlow 1954: 42-43), whereby the soul is released. As explained by Socrates, 'those who practice philosophy in the right way are in training for dying and they fear death least of all men' (*Phaedo* 67e). Moreover, since the souls of such 'philosopher-gnostics' are purified of the mortal body and thereby achieve a likeness to the Divine, they are encouraged by Plato to examine and mythologise (*diaskopein te kai muthologein*) concerning the afterlife (*Phaedo* 61e; Uzdavinys 2011: 75-76).

It is relevant to note that Plato's conception of philosophy as a training for death implies a distinction between philosophy as a way of life on the one hand, and on the other its reduction to rationalistic discourse as in the modern, post-Cartesian West (Uzdavinys 2004: xi). In the Hellenic tradition, philosophy serves to cultivate the various virtues (*aretai*), leading to intellectual vision (*noēsis*) and ultimately *apotheōsis,* when the divine Intellect enlightens the human soul – the final end (*telos*) of human existence. As aptly remarked by Christos Evangeliou, 'Neither Aristotle nor any other Platonic, or genuinely Hellenic philosopher, would have approved of what the modern European man, in his greedy desire for profit, and demonic will to power, has made out of Hellenic *philosophia*' (quoted in Uzdavinys 2004: xi-xii). Related to philosophy as way of life, is the Hellenic distinction between intellect and reason. In terms thereof, reason (*dianoia*) is an individual faculty limited to humans, whereas intellect (*nous*) is universal and found in all beings, albeit in various degrees depending on their ontological level (Schuon 1993: xxix-xxx). The two are yet related, since reason is the power of the soul which derives the principles of its reasoning (*logismos*) from the intellect (Taylor 2010: 104, 108). However, in most of Western philosophy, at least since the Cartesian revolution, these realms have become conflated.

Furthermore, the metaphor of the charioteer in Plato's dialogue *Phaedrus* resembles in detail that of the *Katha Upanishad*: 'Know the self (*Atman*) as the Lord who sits in the chariot called the body; *buddhi* (intelligence) is the charioteer; mind the reins, the senses are the horses, and the objects are the roads. The self is the controller and enjoyer. But he who has no understanding, but is weak in mind, his senses run riot like the vicious horses of a charioteer. He who has understanding and is strong-minded, his senses are well-controlled like the good horses of a charioteer' (cited in Marlow 1954: 43). In the *Phaedrus* Plato depicts the soul as consisting of three parts, represented by the charioteer, a good horse with self-control, and a bad horse that needs to be disciplined by the charioteer (253d-254d). That Plato's metaphor is not an isolated one in Hellenic thought is evident from similar images used by Orpheus and Parmenides (Uzdavinys 2011: 73).

The Indo-Hellenic notion of the soul's primacy over the body implies that pure knowledge (Sanskrit *jnana*, Greek *gnōsis*) is only attainable after death.[4] As declared by Socrates, 'It really has been shown to us that, if we are ever to have pure knowledge, we must escape from the body and observe things in themselves with the soul by itself' (*Phaedo* 66e). By dying to the body, the true philosopher (*philosophos*, 'lover of wisdom') acquires knowledge of the noetic realm, and thus becomes akin to the Forms. Consequently, 'The Parmenidean and Platonic lover of knowledge is akin to the divine and immortal Being' (Uzdavinys 2011: 75). As a matter of fact, for Plato 'the Divine' (*to Theion*) signifies being subsisting in conjunction with the One, to which all things are secondary (Taylor 2010: 104).

Regarding this earthly life, Plato wrote in his *Letter VII* that three things are necessary to obtain knowledge (*epistēmē*) of any real being: the name, the definition, and the image. For example, the entity known as a circle is named thus, its definition consists of nouns and verbs ('the figure whose extremities are everywhere equally distant from its center'), and its image is drawn or erased. However, Plato remarks, 'the circle itself to which they all refer remains unaffected, because it is different from them.' In this way the name, the definition and the image provide knowledge (which thus comes fourth) of the object itself, which is fifth in the sequence. This pertains to geometrical figures, to colours, to artificial and natural bodies, to the elements, to all living beings and their souls, and also to the good, the beautiful, and the just, Plato adds. 'For in each case, whoever does not somehow grasp the four things

4 The Sanskrit *jnana*, the Greek *gnōsis* and also the Latin *co-gnoscere* has been related by Rene Guénon to self-realisation. These cognate terms express 'an idea of "production" or "generation" because the being "becomes" whatever it knows and realizes itself through that knowledge' (1945: 76).

mentioned will never fully attain knowledge of the fifth' (*Letter VII*).

That both spiritual and physical sight are related to true knowledge (Sanskrit *vidya*) is evident from the fact that the classical Indian religious texts, the Vedas, derive their name from the root *vid*, which contains the two-fold meaning of seeing (Latin *videre*) and knowing (Greek *oida*). Accordingly, 'sight is taken as a symbol of knowledge because it is its chief instrument within the sensible order; and this symbolism is carried even into the purely intellectual realm, where knowledge is likened to "inward vision", as is implied by the use of words such as "intuition" for example' (Guénon 1945: 14). This reasoning implies further that the physical cannot be divorced from the metaphysical, which provides its ontological foundation.

The relativity of human knowledge is recognised in both Indian thought and in Plato's epistemological dialogue *Theaetetus* (Marlow 1954: 44). Thus in the latter Socrates explains a notion attributed to Protagoras, Heraclitus and Empedocles: 'I mean the theory that there is nothing which in itself is just one thing: nothing which you could rightly call anything or any kind of thing. If you call a thing large, it will reveal itself as small, and if you call it heavy, it is liable to appear as light, and so on with everything, because nothing is one or anything or any kind of thing' (152d). Consequently, Socrates argues, 'In the sphere of vision... what you would naturally call a white color is not itself a distinct entity, either outside your eyes or in your eyes. You must not assign it any particular place' (153d-e). Furthermore, Plato admits that due to the weakness of language and the unreliability of sense perception it is extremely difficult to arrive at knowledge of real beings. None of the four instruments mentioned earlier (i.e. name, definition, image, and knowledge) can provide the soul with the objects of her search, namely the particular quality and the being of an object (*Letter VII*). The Hellenic recognition of the relativity of human knowledge is thus attributed to Socrates, who to some extent anticipated the subversion of knowledge by Nagarjuna in India. However, the latter thinker took a more radical approach, by undermining empirical knowledge in order to facilitate the arising of mystical understanding (Krüger 2007: 143).

According to the Vedanta, the various states of consciousness are first the waking state (*Vaishwanara*), then the dream state (*Taijasa*), and finally deep sleep, or *Prajna* (Guénon 1945: 88, 90, 96, 103). Plato makes a similar distinction and relates it to epistemology: 'Indeed we may say that, as our periods of sleeping and waking are of equal length, and as in each period the soul contends that the beliefs of the moment are preeminently true, the result is that for half our lives we assert the reality of the one set of objects, and for half that of the other set. And we make our assertions with equal conviction in both cases' (*Theaetetus* 158d). Finally, Plato's theory of the origin of words evokes the *Nyaya* system of logic. Just as the Athenian thinker declares that the true meaning of a word goes back to the individual letters composing it, from which words are formed and ultimately sentences, which are 'something important, beautiful, and whole' (*Cratylus* 424c-425b), the Indian system reduces the meaning of a word to the significance of its letters (Marlow 1954: 44-45).

However, one should not disregard the aspects in which Indian and Hellenic philosophy diverge from each other. This pertains notably to logic, of which Aristotle laid the foundations for much of subsequent Western thought. For instance, according to the Aristotelian principle of excluded middle every proposition is either true or false, thereby excluding the possibility that a proposition might be partially correct (Blackburn 2008: 124). As remarked by the South African philosopher Kobus Krüger, this approach encourages either/or thinking which views either a significant statement or its negation as being true. In contrast, classical Indian thought developed a more conjunctive type of logic. Thus Jainism taught a seven-fold scheme, allowing for seven statements made from different perspectives to be true in a complementary sense. And in early Buddhist logic a four-fold scheme arose, in terms of which there are four valid types of propositions: A is B; A is not-B; A is B and not-B; and A is neither B nor not-B. Applied to cosmology, the early Buddhist logic developed as follows: (i) this world is finite; (ii) this world is infinite; (iii) this world is both finite and infinite; and (iv) this world is neither finite nor infinite. Such statements could refer to different aspects of the same reality, so that they may be contrary but not necessarily contradictory (Krüger 2007: 19-20).

Concluding his informative juxtaposing of Indian and Hellenic philosophy, Marlow suggests that Indian influence probably reached Greece through Persia as intermediary (1954: 45). Without denying a flow of thought in either direction, we contend that the striking parallels between Hellenic and Indian philosophy should primarily be ascribed to a common spiritual-intellectual tradition among the various Indo-European peoples. For instance, their names for the supreme Deity suggest a common origin. The earliest Indo-European name for God was *Dyaus Pitar* in Sanskrit, meaning 'Heavenly Father', and was used by the Indo-Aryans as early as around 1500 B.C. Similarly, we find *Zeus Pater* (or simply *Zeus*) among the Hellenic peoples, *Ju-piter* (or simply *Deus*) among the Italic peoples, *Teu* among the Teutons and Saxons, *Tir* among the Norse peoples, as well as *Ziues* in old High German. All of these names are linguistically related to *Dyaus* and *Deus* (Campbell 1970: 9-10). We will now consider relevant aspects of the traditional Indo-European metaphysics and cosmology.

2.3 Being and Manifestation

Why is there something instead of nothing? Or, stated in ontological terms, why is there being instead of non-being? According to the early Hellenic thinker Parmenides a distinction has to be made between 'the one, that it is and that it is not possible for it not to be', and 'the other, that it is not and that it is necessary for it not to be' (Fragment 2; quoted in McKirahan 1994: 152). An identical terminology is encountered in the *Bhagavad-Gita*: 'What is non-Being is never known to have been, and what is Being is never known not to have been' (2:16). This differentiation implies that being and non-being are distinct domains, with no possibility of nothing becoming something or vice versa. However, transcending both being and non-being there is the Absolute reality of God/Brahman/the One: 'I will expound to thee that which is to be known and knowing which one enjoys immortality; it is the supreme Brahman which has no beginning, which is called neither Being nor non-Being' (*Bhagavad-Gita* 11.12).

One of the most important metaphysical thinkers of the twentieth century, Martin Heidegger, opens his *Introduction to Metaphysics* (written as supplement to his seminal *Being and Time*) with the following question: 'Why are there beings at all instead of nothing?' This is posited by the German philosopher as the fundamental question of metaphysics – not as the first in chronology but in rank, because it is the broadest, the deepest, and the most originary question. It is the broadest in scope, being limited only by what never is, i.e. non-being; it is the deepest question, aimed at establishing the ground from where beings come and to where beings go; and it is the most originary question, addressing not a particular being but beings as a whole (Heidegger 2000: 1-4). The science of metaphysics thus begins with the question of Being, which in turn is closely related to the notion of 'nature' – on condition that the latter is understood in its original, metaphysical sense and not in a reductionist, material sense.

Among the early Hellenic thinkers, that which is (i.e. the totality of beings), was called *physis*. The term *physis* is usually translated as 'nature', but Heidegger (2000: 15) argued rather persuasively that it harbours a much wider meaning, namely 'what emerges from itself (for example, the emergence, the blossoming, of a rose), the unfolding that opens itself up, the coming-into-appearance in such unfolding, and holding itself and persisting in appearance – in short, the emerging-abiding sway.' Therefore, although *physis* can be experienced in the processes of nature, such as birth and growth, it is not synonymous with these. Instead, *physis* indicates Being-itself, by virtue of which beings appear (Heidegger 2000: 15). It should be noted that the noun *physis* is related to the verb *phuō*, which means ‘to bring forth, produce, or make to grow’ (Liddell and Scott 2004: 772).[5] Accordingly, the early Hellenic thinkers conceived of ‘nature’ as a creative power rather than a material environment (Coomaraswamy 1989: 83). However, Heidegger contends, by translating *physis* into Latin as *natura*, which means ‘birth’, the realm of nature became reduced to the world of biological phenomena. This Latin term therefore represents the beginning of the alienation of Western thought on nature from its original essence in Hellenic philosophy (Heidegger 2000:14). Yet Plotinus recognised an etymological connection between the noun *physis* and the verb *ephy*, that is to say between ‘nature’ and ‘was born’ (*Enneads* VI, 8, 8; Dillon and Gerson 2004: 169). In the light thereof it could more accurately be stated that *natura* is not limited to *physis*, but that it is embraced by the latter (which also reaches beyond the biological realm).

This ontologically inclusive understanding of ‘nature’ implies that physics cannot be divorced from metaphysics without a radical loss of meaning. The Greek prefix *meta* means ‘after’ in the accusative sense (L&S 436), that is to say ‘over beyond’, Heidegger continues, and therefore philosophising about beings as such is *meta ta physika*, or metaphysics. And since physics in the classical Hellenic sense already deals with the Being of beings, it can justly be stated that the essence of metaphysics has from its inception been determined by physics (Heidegger 2000: 18-19). This wider sense of *physis* was recognised by Aristotle with his declaration that metaphysics is the study of being as being (*Metaphysics* Book IV, 1003a; Heidegger 2000: 17).

We have already suggested that Indo-Hellenic philosophy arose from spiritual experience. Arguing along similar lines, Heidegger wrote that for the classical Greeks ontology preceded bio-philosophy: ‘It was not in natural processes that the Greeks first experienced what *physis* is, but the other way around: on the basis of a fundamental experience of Being in poetry and thought, what they had to call *physis* disclosed itself to them. Only on the basis of this disclosure could they then take a look at nature in the narrower sense. Thus *physis* means originally both heaven and earth, both the stone and the plant, both the animal and the human, and human history as the work of humans and gods; and finally and first of all, it means the

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[5] The *Liddell and Scott Greek-English Lexicon* (2004) is hereafter referred to as L&S.

gods who themselves stand under destiny. *Physis* means the emerging sway, and the enduring over which it thoroughly holds sway. This emerging, abiding sway includes both "becoming" as well as "Being" in the narrower sense of fixed continuity. *Physis* is the event of *standing forth*, arising from the concealed and thus enabling the concealed to take its stand for the first time' (Heidegger 2000: 15-16). The German philosopher's argument is relevant to our thesis in several respects: his integration of the metaphysical and the physical into a unified ontological whole; his refusal to dichotomise being and becoming; and his postulation of nature as an unfolding of the concealed, which evokes the correct notion of evolution as the unfolding of inherent potentialities.

The emergence and abiding of Being could equally well be depicted in the terminology employed by the South African philosopher Danie Goosen, building on the notion of theurgy (*theourgia*) developed by the Neoplatonists Iamblichus and Proclus. In terms of Goosen's 'philosophical dramatology', Reality expresses itself in and through the 'actors of being' serving as mediators between the infinity of being and the finitude of the world. These actors assume roles such as being and beings, *esse* and *essentia*, transcendent and immanent, other and self, giver and receiver, subject and object, sublime and beautiful, *eros* and *agapē*, and substantive and accidental (Goosen 2007: 94, 103). Through this dynamic interaction between the One and the many the cosmos obtains the character of a differentiated unity, rather than being monistic or dualistic.

The traditional Indo-European notion of Being has been perceptively sketched by Heidegger through an etymological analysis. The oldest stem word in this regard is *es*, which becomes the noun *asus* in Sanskrit, meaning 'life' or 'the living', and the verb forms *esmi*, *esi*, *esti*, and *asmi*. To these terms are related the Greek *eimi* and *einai* (both meaning 'to be'), and the corresponding Latin terms *esum* and *esse*. In this regard the Germanic verb *ist* is related to the Greek *estin* and the Latin *est*, 'it is'. Another root is the Sanskrit *bhu* or *bheu* and related to the Greek *phuō*, which for Heidegger means 'to emerge, to hold sway, to come to a stand from out of itself and to remain standing.' This is in turn related to the Greek terms *physis* ('nature') and *phainesthai* ('to show itself'), so that nature is described by Heidegger as 'that which emerges into the light, *phuein*, to illuminate, to shine forth and therefore to appear.' The German verbs *bin* and *bist* are also derived from this Sanskrit stem. Finally, the stem *wes* appears in the Sanskrit *vasami* and the Germanic *wesan*, meaning 'to dwell, to abide, to sojourn', which in turn becomes the German verbs *wesen* and *sein*, 'to be' and 'being'. From these three stems, Heidegger concludes, one derives the 'vividly definite' meanings of living, emerging and abiding – none other than the domain of Being (2000: 75, 76).

How and whence does Being arise? According to the metaphysical tradition, all that exists is established by the movement from Principle into Manifestation, which is thus the flow of the One into the many. This Principle, which is transcendent and therefore unknowable in its essence (but not in its immanent energies, as the Greek Patristic theologians emphasised), is variously referred to as Brahman, God, the Good, or the One. It precedes the differentiation between being and non-being: 'There was then neither being nor non-being... Without breath breathed by its own power That One' (*Rig-Veda* X.129; quoted in Perry 1991: 26). The foundation of all that exists in the One, that is to say of the immanent in the transcendent, is affirmed in the *Bhagavad-Gita*: 'By Me [Brahman], unmanifest in form, this whole world is pervaded; all beings are in Me, I am not in them' (9.4). The realm of becoming thus entails a movement from the unmanifested to the manifested. As we read further in the *Bhagavad-Gita,* 'The state of all beings before birth is unmanifest; their middle state manifest; their state after death is again unmanifest' (2.28), and 'But higher than the Unmanifest is another Unmanifest Being, everlasting, which perisheth not when all creatures perish' (8.20).

The supreme Principle is both the Absolute and the Infinite, as distinct from the relative and the finite. This Absolute-Infinite is the Good (*Agathon*) of Plato, and projects the world out of its sovereign Goodness, whereby the Absolute comprises Infinitude and Radiation. The Absolute is thereby reflected in the world in the existence of things (Schuon 1982: 35). And since necessity is related to the Absolute just as freedom is related to the Infinite, 'The universe is a veil woven of necessity and freedom, of mathematical rigour and musical play; every phenomenon participates in these two principles, which amounts to saying that everything is situated in two apparently divergent but at bottom concordant dimensions' (Schuon 2001: 3). Stated in geometrical terms, the point represents the Absolute, the line that extends the point represents Infinity, and the circle represents the projected Good, or Perfection (Schuon 1981: 77). The Absolute Reality that is beyond Being may best be represented by the point, since the void (which would have been a less inadequate representation of It) is not a figure as such. This Reality contains within Itself the principle of polarisation, which is represented by an axis (i.e. a line). From this principial differentiation all the opposites in the cosmos arise, as explained by Frithjof Schuon: 'It is in this first bipolarity, or in this principial duality, that are prefigured or pre-realized all possible complementarities and oppositions: subject and object, activity and passivity, static and dynamic, oneness and totality, exclusive and inclusive, rigour and gentleness' (1981: 65).

Moving from two to three, we encounter the transcendent ternary of the Absolute, the Good, and the Infinite. This is the equivalent of the Vedantic *Sat*, *Chit*, and *Ananda*: Being, Consciousness, and Beatitude (Schuon 1982: 37, 39). These Sanskrit terms are also rendered as Existence, Consciousness, and Bliss, and are in fact the supreme attributes of the One, or Brahman. They represent the summit of the realm of Manifestation, which flows in inexhaustible infinity and timelessness from Brahman (Van Vrekhem 2012: 264). In this Vedantic trinity is also found the divine archetype of all positive ternaries, and it is geometrically represented by the triangle. The latter can be either upright, indicating the return of the many into the One; or it can be inverted, signifying outward radiation, or the production of the many from the One. Two further ternaries mentioned by Schuon are highly relevant in traditional cosmology. One is the macro-cosmic qualities of *tamas, rajas*, and *sattva* (i.e. the ascending, expansive, and descending tendencies in all manifestation); and another is the micro-cosmic (i.e. human) constituents, namely body (*sōma*/*corpus*), soul (*psychē*/*animus*), and spirit (*pneuma*/*spiritus*). The three dimensions of space also provide a natural symbol of the ternary (Schuon 1981: 66-67, 69). According to the *Theology of Arithmetic* attributed to Iamblichus (the longest extant work on the symbolism of numbers from the Classical world), plurality commences its manifestation with the triad: 'The monad is like a seed containing in itself the unformed and also unarticulated principle of every number; the dyad is a small advance towards number, but is not number outright because it is like a source; but the triad causes the potential of the monad to advance into actuality and extension.' Examples of such triadic actualisation are the phases of the moon (waxing, full moon, and waning); the zodiacal circles (summer, winter, and the ecliptic); and the kinds of living creature, namely on land, in air, and in water ('On the Triad'; Waterfield 1988: 50, 52).

The next numerical hypostasis of metacosmic Reality is the quaternity, represented by the (static) square and the (dynamic) cross. In the words of Schuon: 'Quaternity signifies stability or stabilization; represented by the square, it is a solidly established world, and a space which encloses; represented by the cross, it is the stabilizing Law that proclaims itself to the four directions, indicating thereby its quality of totality' (1981: 71). According to Iamblichus, there are four elementary numerical properties: sameness in the monad, difference in the dyad, surface in the triad, and solidity in the tetrad. Further examples of the tetrad in manifestation are the four terrestrial elements and their powers of heat, cold, wetness, and dryness; the four seasons of the year; and the four cardinal points, with the primary winds named after them ('On the Tetrad'; Waterfield 1988: 58-59, 63).

2.4 Essence and Substance

In order to make Manifestation possible, the Principle polarises itself into the two poles of universal Essence, or *Purusha*, and universal Substance, or *Prakriti*, without diminution of its intrinsic unity (Perry 1991: 23). These two poles of Manifestation thus comprise the first cosmic duality, which is not to be confused with any kind of dualism.[6] *Purusha* and *Prakriti* are the Sanskrit equivalents of the Greek terms *eidos* and *hylē* (usually translated as 'form' and 'matter'), denoting universal Essence and Substance respectively (Guénon 1945: 48). Although producing the cosmos, Essence and Substance are outside time, or eternal, as declared in the *Bhagavad-Gita*: 'Know that *Prakriti* and *Purusha* are both without beginning; know that all the modifications and *gunas* are born of *Prakriti*' (11.19). These *gunas* exist in perfect equilibrium within *Prakriti* in its primordial state, while every manifestation of Substance represents a rupture of that equilibrium. The three *gunas* are the upward tendency of *sattva*, the expansive tendency of *rajas*, and the downward tendency of *tamas* (Guénon 1945: 52). And since manifestation represents a movement away from the Principle, the creation of the world is in a sense a victory of *tamas* over *sattva*, until the cosmic balance is partly restored with the *Fiat Lux*, the creation of light (Lings 1974: 109).

As the essential principle of all things, *Purusha* determines the possibilities of manifestation contained within *Prakriti*. Stated in Aristotelian terms, *Purusha* effects the passage of all things from potency to actuality (Guénon 1945: 55). Furthermore, *Purusha* is related to *Atma*, or Spirit (Greek *pneuma*, Latin *spiritus*), in the sense of the divine Essence. And although *Atma* always remains unmanifest, it produces *Buddhi*, or Intellect (Greek *nous*), as first and highest of the manifested principles (Guénon 1983: 1). Intellect thus represents the level of informal manifestation, which is to say that *Buddhi* is above individual manifestation. Moreover, as first manifestation of Spirit, Intellect 'constitutes the link between all the states of manifestation, but from another angle, envisaging things from a principial viewpoint,

[6] The difference between duality and dualism has been lucidly explained by René Guénon: 'Dualism (of which the Cartesian conception of "spirit" and "matter" is among the best known examples) properly consists in regarding a duality as irreducible and in taking account of nothing beyond it, thereby denying the common principle from which the two terms of the duality really proceed by "polarisation"' (1995: 354). That is to say, the recognition of Essence and Substance as the first cosmic duality does not imply any metaphysical dualism, since both these poles of Manifestation are derived from a single Principle.

Buddhi appears as the luminous ray emanating from the spiritual Sun, which is *Atma* itself' (Guénon 1983: 2). Accordingly, from the viewpoint of manifested being there is no real difference between spirit and intellect, so that *Atma* and *Buddhi* appear as interrelated.

The interaction between Essence and Substance produces the realm of Manifestation. This transcendent Essence is eternally radiated into the realm of dimensional existence (i.e. manifestation) through the Word (Logos) of God. Stated in astrophysical terms, 'The echo of this eternal radiation, in the world of space and time, is the Big Bang' (Upton 2008: 193). In the manifested world the Infinite thus appears as modes of extension, as explained by Frithjof Schuon: the conserving mode is space, the transforming mode is time, the qualitative mode is form, the quantitative mode is number, and the substantial mode is matter. Space, time, form, number, and matter are thus the 'pillars of universal existence' (1982: 35-36). Accordingly, the sensible world is manifested through the modes of matter, form, and number: the fundamental matter is ether, the fundamental form is the sphere, and the initial number is one, or unity. Each mode develops in its own particular manner: matter extends from substantiality to accidentality; form evolves from spherical simplicity to indefinite complexity; number develops from unity to totality, space from point to limitless expansion, and time from the instant to eternity. Each of these modes of unfolding presents an image of the Principle realising its potentialities in the direction of relativity or contingency (Schuon 1982: 57-58).

What is the status of individual beings in the traditional Indo-European conception? Each manifested being is a composite of form (Greek *eidos*) and matter (*hylē*), these terms being the equivalent of the Sanskrit *nama* and *rupa*. Such a composite being could therefore be described as 'en-mattered form', or *nama-rupa* (Guénon 1995: 20-21, 337). In his *Notes on the Katha Upanishad*, Ananda Coomaraswamy remarked that all manifestation is expressed in the terms *nama-rupa*, which correspond to the Platonic intelligible and sensible worlds, i.e. the Essence and Substance of things (cited in Guénon 1995: 34). In the case of living beings this composition appears as the two levels of formal manifestation, namely the psychic (Greek *psychikos*) and the corporeal (*somatikos*), or soul and body respectively. And since spirit, that is to say intellect, can never be individual or corporeal, it is transcendent in relation to the combination of soul and body. Therefore, a human being cannot speak of 'his' or 'her' spirit, as can indeed be predicated of the soul and body (Guénon 1983: 2-3). In other words, spirit is supra-individual, whereas soul and body pertain to the individual order. Furthermore, each individual being is the result of action exercised by Essence (as active principle) on Substance (as passive principle). This dynamic ontological notion corresponds to the Aristotelian metaphysics of act and potency: act is that by which a being participates in Essence and potency is that by which it participates in Substance. Therefore, pure act and pure potency do not exist in the realm of manifestation, since they are the equivalents of universal Essence and Substance (Guénon 1995: 20-21). Stated in Aristotelian terms, pure act and pure potency are represented by the pre-ontological extremes of the Prime Mover and primary matter.

In Hellenic philosophy the ontological pole of Essence, or *Purusha*, is signified above all by the Platonic Forms, or Ideas. Whereas Plato emphasises the transcendent aspect of the Forms and Aristotle their immanent aspect, these approaches are not at all incompatible, since both consider the archetypes or essential principles of things, which represent the qualitative side of manifestation (Guénon 1995: 23). Moreover, since the Platonic Forms are equivalent to the Pythagorean numbers, the latter are not to be understood in the ordinary, quantitative sense of the word, but as qualitative and essential whereas quantitative numbers are substantial. As explained by René Guénon (1995: 337), 'It may be observed that the name of a being, in so far as it is an expression of its essence, is properly speaking a number understood in this qualitative sense; and this establishes a close link between the conception of the Pythagorean numbers, and consequently that of the Platonic ideas, and the use of the Sanskrit word *nama* to denote the essential side of a being.' In the light of this distinction, the Scholastic translation of the Greek *ousia* (essence) into the Latin *substantia* inevitably leads to the linguistic confusion encountered in the notion of 'substantial form', which confuses the essential side of a being with its substantial side (Guénon 1995: 337).

For the sake of conceptual clarity it has to be emphasised that the Aristotelian notion of matter (*hylē*) and the Scholastic notion of *materia* are not in the least identical to the modern, reductionist view of matter, but both instead signify universal Substance, or *Prakriti*. Furthermore, as universal principle *hylē* is pure potency, in which nothing is actualised. It thus constitutes the passive support of all manifestation, whereas Form (*eidos*) constitutes the active element (Guénon 1995: 25). It is also pertinent to note that the primary meaning of the word *hylē* is related to the vegetative principle, namely 'wood' – in other words, *hylē* alludes to the 'root' (Sanskrit *mula*, Greek *rhizōma*) which is the starting point of manifestation (Guénon 1995: 337). The relation between matter and its potentiality has been stated as follows by Frithjof Schuon: 'to say matter, or mass, or ether, is to say energy, possibility of action, hence of change and consequently of time' (1982: 64).

In the traditional conception, the world is constituted by successive differentiations out of *materia prima*. Since the latter is unformed and intangible, it is inaccessible to all distinctive knowing. Conversely, 'The world that is accessible to such knowing therefore extends between two poles that are unmanifested as such, the informing essence and the undifferentiated *materia*, just as the range of colors in the spectrum opens out through the refraction of white light – as such colorless therefore – in a similarly colorless medium' (Burckhardt 1974: 135). Since universal Substance is the pure potency underlying all manifestation, it is 'that which stands beneath', the latter phrase being the precise meaning of the Latin *sub stare*, from which *substantia* is derived (Guénon 1995: 26), as is the case with the Greek *hypostasis*. As universal Substance it gives rise to the world of phenomena through the various elements: 'Earth, Water, Fire, Air, Ether, Mind, Reason, and Ego – thus eightfold is my *Prakriti* divided' (*Bhagavad-Gita* 7.4). This underlying Substance, or *Prakriti*, is undifferentiated and unintelligible, since there is nothing in it that can be known (Guénon 1995: 26). Plato therefore insists that the receptacle of becoming out of which the Demiurge fashions the sensible world is without characteristics and difficult to describe (*Timaeus* 49a, 50b-51b). Moreover, due to the unintelligibility of Substance, the explanation of things should not to be sought on the substantial side but on the essential side. Stated in terms of spatial symbolism, explanation should be directed from above downwards and not from below upwards (Guénon 1995: 26, 27). This notion is also found in the Hermetic writings of the Egyptian wisdom tradition, 'The cosmic forces do not work upward from below, but downward from above' (Perry 1991: 41) – hence the Hermetic maxim, 'As above, so below.'

In Hellenic philosophy this explanatory approach is particularly evident in Neoplatonism, as Lloyd Gerson explains: 'What is most distinctive about Platonism, especially as it is represented by the Neoplatonists, is that it is resolutely and irreducibly top-down rather than bottom-up. A top-down approach to philosophical problems rejects... the claim that the most important and puzzling phenomena we encounter in this world can be explained by seeking the simplest elements out of which they are composed. The top-down approach appeals to first or higher or irreducible principles to account for these phenomena' (2005: 31-32). It is for this reason, Guénon argues, that modern science (in the Cartesian and Newtonian sense) lacks explanatory value. For instance, modern science leads to contradictions such as speaking of the properties of matter while asserting that matter is inert. It should also be kept in mind that 'body' and 'matter' are not synonymous concepts, since in reality bodies proceed from matter as their substantial principle (Guénon 1995: 27, 31).

2.5 Matter, measure, and number

The Latin term *materia* is related to *mater,* 'mother', thus reflecting the Indo-European notion of Substance as the passive principle in manifestation and symbolically feminine (Guénon 1995: 338). In addition, *materia* is related to the notion of measure. It has been suggested by Guénon (1995: 338) that William Blake's drawing of the 'Ancient of days' reflects the statement in the *Rig-Veda* (VIII, 25, 18), 'With his ray he hath measured (or determined) the bounds of Heaven and of Earth.' Coomaraswamy remarked that the Sanskrit *matra*, measure, is the equivalent of *materia*, although that which is measured is not matter as such, but rather the possibilities inherent in spirit, or *Atma* (Guénon 1995: 34). It could therefore be stated that matter is the sensible manifestation of existence itself; form is the manifestation of a divine Idea, or archetype; and number manifests the infinitude of the Possible (Schuon 1982: 57).

Although measure is mainly concerned with the domain of continuous quantity, matter cannot be reduced to extension (as was defined by Descartes), since measure is primarily geometrical on account of bodies occupying a defined part of space (Guénon 1995: 35). Coomaraswamy remarked that the Platonic concept of measure (Greek *metron*) corresponds with the Indian concept thereof, in terms of which the non-measured is the indefinite; the measured is the defined or finite, i.e. the ordered universe; and the non-measurable is the Infinite, which is the source of both the indefinite and the finite (Guénon 1995: 37, 38). The Infinite that encompasses both non-being and Being is none other than God/Brahman/the One.

Furthermore, the Indo-European notion of measure is intimately connected with that of 'order' (Sanskrit *rita*, Greek *kosmos*), which in turn is related to the production of the cosmos (Guénon 1995: 38). The coming-to-be of the universe is thus a production of order out of chaos, as is reflected in the etymology of the Greek terms *kosmos*, orderly arrangement, and *kosmeō*, to order or arrange (L&S 389). Chaos is symbolically identified with darkness, signifying that potentiality which is the substantial side of the world or the tenebrous pole of existence, whereas Essence is the luminous pole which illuminates chaos in order to extract cosmos from it. The notion of the coming-to-be of cosmos out of chaos also agrees with the Sanskrit *srishti*, meaning the production of manifestation, and containing the related ideas of expression, conception, and luminous radiation (Guénon 1995: 38). In addition, the Indian notion of *rita* signifies the law of nature or the course of things, equivalent in scope to the

Greek *dikē*, meaning order, law, or right (L&S 173). This notion of natural lawfulness is stated by Heraclitus as ‘The sun shall not transgress its bounds’ (Fragment 94), reflecting similar statements in the *Rig Veda* (I.24.8 and I.160.1; Marlow 1954: 36). Finally, the Sanskrit *rita* is closely related to ‘rite’, which imitates or reproduces the process of manifestation. This correlation explains why in a traditional civilization every human act acquires an essentially ritual character (Guénon 1995: 338). In the anti-traditional modern world, the value of ritual acts has consequently been rejected in the name of a false, individual ‘freedom’, which manifests as all manner of deviant behaviour masquerading as ‘self-expression.’

Since number is the symbol of causal necessity, ‘it contains the ultimate meaning of the world-as-nature’, Oswald Spengler argued. Number is furthermore the primary element on which all mathematics is based. Accordingly, ‘It [mathematics] is a science of the most rigorous kind, like logic but more comprehensive and very much fuller; it is a true art, along with sculpture and music; it is, lastly, a metaphysic of the highest rank, as Plato and above all Leibniz show us’ (Spengler 1991: 42-43). A distinction is however made by the German philosopher between the Hellenic and Indian conceptions of number. Since the Hellenic notion of number deals only with ‘visibly limitable and tangible units’, its mathematics recognises only positive and whole numbers. Thus decimal fractions, negative numbers, and even the number zero are disregarded by the classical Greeks. In contrast, Indian mathematics recognises the number zero as a base for ‘positional numeration’, thus providing a key to the meaning of existence (Spengler 1991: 48-49). In Sanskrit the zero is referred to as *Sunya*, meaning void or emptiness. It thus probes the borderline between absence and presence, signifying the pregnant ground of all being, as noted by Miranda Lundy (2010: 56).

In Hellenic philosophy the process of manifesting universal order is depicted above all in the Pythagorean numerology. To the Pythagoreans the sacred number is ten, the *Tetraktys*, being the sum of the first four whole numbers: 1+2+3+4=10. Interestingly, the reverse order thereof is found in the Indian notion of the four *Yugas* that constitute a cosmic cycle, or *Manvantara*. The *Yugas* (of which we live in the fourth and darkest, the *Kali Yuga*) decrease in duration in the proportion 4:3:2:1, which gives a total of ten for the entire cycle (Guénon 1995: 55, 340, 346). The numerical basis of cosmic manifestation is also echoed in the Biblical statement that God ordered all things by measure, number, and weight (*Wisdom of Solomon* 11:20). This verse is read by Thomas Aquinas as meaning, ‘by measure the amount or mode or degree of perfection in each thing, by number the diversity and plurality of species that results from these degrees of perfection, and by weight the diverse attractions to specific goals and activities, agents and patients, and properties resulting from the diversity of species.' Thomas also refers to the statement by Boethius (in the *Arithmetic*) that 'everything laid down in the primeval nature of things seems to have been formed by reason of number' (*Summa contra Gentiles*, 3.97-98; McDermott 1993: 273).

The relation between number and form is that 'form is static by its determining contours, but number is dynamic by its augmenting and diminishing function' (Schuon 1982: 58). While number primarily indicates quantity and form quality, number also has a qualitative aspect (as in Pythagorean geometry, for example duality and trinity) and form has a quantitative aspect in as much as it lacks content. In spatial terms, form relates to the centre while number refers to extension. Moreover, form reveals the divine perfection through diverse modes of beauty or functionality, while number entails the numerical principles symbolised above all by geometrical figures (Schuon 1982: 65, 70). And since the world is thus grounded in the divine perfection on account of form, Lord Northbourne remarks, it is 'perfection manifested in imperfection, the absolute in the relative, the infinite in the finite; every part of the world mirrors the whole' (1995: 99).

In the Indo-European understanding every measurement is essentially geometrical, with geometry understood in its symbolic sense (Guénon 1995: 39). Thus is it declared by the Presocratic cosmologist Pherecydes Syrus in his *Hymn to Jupiter*: God is circle, square and triangle, line and centre, and all things before all (Taylor 2010: 24-25). This sense of sacred geometry has been expressed by Plato as *aei ho theos geometrei*, or God geometrises always. A late echo of this Pythagorean notion in modern philosophy is found in the work of Leibniz, who declared that 'while God calculates and practises His cogitation (that is to say, set out His plans) the world is made' (quoted in Guénon 1995: 41). The divine activity of producing and ordering the world is thus assimilated to geometry and architecture. The inseparability of these subject areas is affirmed by the Arabic word for measure, *hindesah*, which denotes both geometry and architecture, since the latter is the 'practical' application of the former (Guénon 1995: 40, 338). That is to say, in as much as architecture is the extension of plane geometry into three-dimensional space, it also has be viewed as a sacred art.

2.6 Time and space

Since Manifestation occurs within the realms of space and time, we will briefly consider the traditional Indo-European conception of its interaction. To begin with, just as the Infinite is the complement of the Absolute, so time is both inherent in space and proceeds from it. Thus time is the complement of space, just as energy is the complement of matter (Schuon 1982: 64). Furthermore, time can only be measured indirectly by means of relating it to space through the intermediary of movement (Guénon 1995: 35). In other words, motion (Greek *kinēsis*) provides the link between space and time as far as measurement is concerned. In its turn space constitutes the 'field' (Sanskrit *kshetra*) within which corporeal manifestation occurs (Guénon 1995: 40). On the one hand time 'consumes' or compresses space, but on the other hand time is also subject to progressive contraction during a cycle of manifestation, as appears in the proportionate shortening (4:3:2:1) of the four *Yugas* (Guénon 1995: 191). At the extreme limit of cyclic manifestation time ceases to exist – when that point has been reached, time has been changed into space, in other words, space in its turn 'consumes' time. This phenomenon is expressed partially in physical and mathematical theories that treat of 'space-time' as a single and indivisible whole. In reality, time is only comparable to a fourth dimension in equations of movement, where time acts as a fourth co-ordinate added to the three dimensions of space (Guénon 1995: 192, 193). The model of 'space-time' as a four-dimensional continuum as postulated in the Theory of Special Relativity is therefore valid in terms of motion.

As affirmation of this notion that the transmutation of time into space is only realisable at the end of a cosmic cycle, it should be noted that the 'end of the world' is commonly referred to in religious language as the 'end of time' and never as the 'end of space'. Strictly speaking, both the end of a cycle of manifestation and its beginning is timeless, and therefore the end of a cycle entails the restoration of its primordial state (Guénon 1995: 193, 194, 351). Or as stated by Meister Eckhart, referring to the scriptural *In principio,* 'in the beginning': 'It also means the end of all things, since the first beginning is because of the last end' (quoted in Perry 1991: 26). Viewed in spatial terms, the movement from Essence towards Substance is also the movement from centre towards circumference, from interior towards exterior, and from unity towards multiplicity. In symbolic language the 'centre of the world' is the location where time is changed into space (Guénon 1995: 195, 196).

The Indo-European concept of cosmic cycles is associated with the conviction that instead of the world being the unique creation of a Deity and therefore having a beginning in time, the existence of the cosmos entails a beginning-less and endless succession of world origins and world endings. This cyclic cosmogony was taught by early Hellenic thinkers such as Anaximander, Heraclitus and Empedocles, and by the Roman poet Lucretius in his didactic poem *De rerum natura* (On the nature of things). It also found expression in the Germanic world in the first poem of the *Poetic Edda*, titled *Völuspá* (Günther 2013: 12). The cyclical interaction between cosmic creation and destruction is provided with a theistic basis in the Indian concept of *Trimurti* (Sanskrit: ‘three forms’), in terms of which Brahma is the creator, Vishnu the preserver, and Shiva the destroyer or transformer (Wikipedia: Trimurti).

2.7 Sphere and cube

The sphere is the primordial geometrical form, being the least specified of all and similar to itself in all directions. It is therefore the most universal form, containing all the other forms (pyramid, cube, etc.) which will emerge from it through differentiation in particular directions. In addition, the sphere is symbolized by the ‘Egg of the World’ in various traditions, out of which all the possibilities develop during the course of a cycle of manifestation (Guénon 1995: 170). It is of particular relevance to the notion of lawful evolution that the sphere is found at the beginning of the embryonic existence of every individual being. Accordingly, the embryo is the microscopic analogy of the ‘Egg of the World’ in the macroscopic order (Guénon 1995: 344). This notion of a World-egg that gives birth to the cosmos is encountered in both the *Rig Veda* (X.82.5-6) and in Orphism.

According to the *Orphic Fragments*, the first divine couple is Sky, or Heaven (*Ouranos*), and Earth (*Gaia*). United by Love (*Eros*), the Heaven embraces and fertilises the Earth with his rain. This reproductive union is similarly evoked by the sky-god Zeus/Jupiter fertilising Semele, representing the Earth, as well as Zeus fertilising the earthly Danae after he is transformed into golden rain (Theodossiou *et al* 2011: 91). According to Marlow, the Orphic cosmogony differs in this regard from that of Homer and Hesiod, who both saw Ocean as the origin of all things (1954: 40). However, Ocean in its turn was born from the union of Earth (*Gaia*) and Heaven (*Ouranos*), as Hesiod writes in the *Theogony*. The Orphic and Hesiodic cosmogonies could therefore be viewed as complementary.

In three-dimensional geometry the cube is the opposite of the sphere, representing the most specified of all forms. The cube is related to the earth as element (Plato, *Timaeus* 55e) and corresponds to the final stage of a cycle of manifestation. Moreover, in terms of manifestation the sphere is related to the essential pole and the cube to the substantial pole (Guénon 1995:

171). It is therefore not surprising that the instruments used to draw these forms, i.e. the compass and the square, are respectively analogous to the essential (or masculine) pole and the substantial (or feminine) pole of manifestation (Guénon 1995: 173, 345).

Although not directly related to Indo-European thought, it is interesting to note that in classical Chinese philosophy spherical or circular forms are related to Heaven (*Tien*) while cubic or square forms are related to Earth (*Ti*). The Chinese notions of Heaven and Earth are thus equivalent to the Indian notions of *Purusha* and *Prakriti* (Guénon 1995: 172). It is stated in both the *Rig Veda* and Hesiod's *Theogony* (at 126) that Earth and Heaven are the parents of the gods (Marlow 1954: 36), thus affirming in symbolical language that all manifestation arises through the interaction between Essence and Substance.

2.8 The metaphysical concept of evolution

In view of the prevailing confusion regarding the meaning of evolution, a distinction has to be made between evolution in the metaphysical sense of the word and the theory of evolution as postulated by Charles Darwin and his followers. The term 'evolution' is derived from the Latin *evolvere*, which means the de-velopment of that which is en-veloped (Gilson 2009: 59). In other words, 'the cosmos becomes what it is through an "unwinding" or explication of What is already inside, which is "turned out" or *evolved* into what it is initially not but can then be seen in' (Cutsinger 2007: 11). Or as stated by Aurobindo, evolution is an inverse action of involution. 'In a sense,' the Indian sage adds, 'the whole of creation may be said to be a movement between two involutions, Spirit in which all is involved and out of which all evolves downward to the other pole of matter, Matter in which all is involved and out of which all evolves upwards to the other pole of Spirit' (quoted in Van Vrekhem 2012: 264). This reference to Spirit and Matter should strictly speaking be understood as denoting Essence and Substance, as we noted earlier.

Another common misconception is that the idea of evolution is a discovery of modern science, effectively replacing theological doctrines on Divine creation that had previously held sway. As a matter of fact, Osman Bakar noted, the concept of evolution is originally of metaphysical provenance, pertaining to the Chain of Being reaching from God down to inanimate matter. However, due to the almost complete loss of metaphysical awareness in the Western world by the nineteenth century, 'The evolutionary chain of living organisms in post-Darwinian biology is none other than the secularized and temporalized version of the traditional metaphysical doctrine of gradation or the “great chain of being” of the Western tradition’ (Bakar 2003: 164).

In a brief yet perspicacious essay titled *Gradation and Evolution,* Ananda Coomaraswamy made a similar distinction between the traditional, metaphysical doctrine of gradation and the modern, mechanistic theory of evolution (Bakar 2003: 166). To begin with, Coomaraswamy concurs with the Latin Christian theologian Augustine that nothing in the world happens by chance – rather, what happens is always the realisation of a possibility (1989: 70). However, Thomas Aquinas noted, potentiality (i.e. possibility) should not be confused with actual pre-existence. Instead, anything that nature produces must exist potentially (since nature cannot produce something from nothing), but it does not have to actually pre-exist, since what exists cannot come to exist (*Quaestiones Disputatae de Potentia*, 3.7-8; McDermott 1993: 311). The metaphysical concept of evolution views all living beings as physical manifestations of inherent possibilities. By way of analogy Frithjof Schuon compared the evolution of the cosmos (and by extension all life in it) with embryonic development: ‘In the same way the whole cosmos can only spring from an embryonic state which contains the virtuality of all its possible deployment and simply makes manifest on the plane of contingencies an infinitely higher and transcendent prototype’ (*Understanding Islam*; quoted in Cutsinger 2007: 23-24).

What is the causal basis for the movement from possibility to manifestation as it pertains to the organic realm? Coomaraswamy suggests that two orders of causes are involved: initially there is the First Cause, in which all possibilities inhere; and then there are the mediate causes, providing the conditions in which the possible becomes the necessary. The First Cause is the direct cause of the being of things, but not of their manner of being. The latter is determined by mediate causes, producing a given species or individual at a given time and place. When the mediate causes converge to establish the spatial and temporal environment for a given possibility to be actualised, the corresponding form emerges. This implies, for example, that mammals could not have appeared before the operation of natural causes had prepared the earth for mammalian life. Accordingly, an evolutionist could employ mediate causes for an explanation of his or her observations, while omitting the First Cause because he or she is dealing with biodiversity and not with the origin of life as such (Coomaraswamy 1989: 71, 74, 83).

This distinction between the First Cause and mediate causes has been related by Thomas

Aquinas to the two sorts of order, namely the universal and the particular. The one universal order depends on the First Cause of everything and thus embraces everything. In contrast, the many particular orders depend on some created cause and extends to whatever is subordinate to that cause. Thomas adds, 'Necessarily then all these particular orders are subordinate to the one universal order, descendants of that order of things which results in them because of their dependence on the first of causes' (*Summa contra Gentiles*, 3.97-98; McDermott 1993: 275). Evidently, the distinction between the First Cause and mediate causes should not be conceived as a separation of the physical from the metaphysical. As emphasised by Frithjof Schuon, 'Even within the order of physical causes, one has to take into account the simultaneous presence of the immanent metaphysical Cause: if a seed is the immediate cause of a plant, it is because the divine archetype intervenes in the physical causality' (2001: 4). This coherence between the metaphysical and the physical is due to their common foundation in the One.

In the light of the foregoing, evolution should be defined as the unfolding (Latin *evolutio*) of inherent possibilities in organisms. In Aristotelian terms, evolution entails a movement from potentiality to actuality, which in the case of living organisms entails a formation of matter by soul. And since evolution entails a movement from a form (*eidos*) towards an end or purpose (*telos*), both formal and final causality should be recognised in an authentic theory of evolution. Clearly, such an understanding is at odds with the modern biological definition of evolution as 'the genetic transformation of populations through time, as a result of genetic variation and subsequent environmental impact on the rates of reproductive success' (Blackburn 2008: 123), which recognises only material and mechanical factors as causes of biodiversity. Instead, as declared by Richard the Englishman, 'Nothing can be produced from a thing that is not contained in it; by this fact, every species, every genus or every natural order develops within the proper limits to it and bears fruits according to its own kind and not according to an essentially different order' (quoted in Burckhardt 1974: 147).

According to the traditional doctrine of evolution, Coomaraswamy adds, every phenomenon represents one of the possibilities of manifestation of Plato's 'ever-productive nature' (*aeigenēs physis*), as mentioned for instance in the *Laws* (773e; 1989: 81). This ever-productive nature is referred to variously in different traditions as God, Spirit, or Life – terms signifying the First Cause of all living beings. God endows all things with life impartially, while leaving the manner of their existence to the operation of mediate causes with which He does not interfere (Coomaraswamy 1989: 73, 84). Although arguing from an atheistic angle, the French geologist Paul Lemoine echoed this metaphysical notion of nature's fecundity by postulating an infinite number of living forms that could be dormant, and ready to appear when their conditions of existence present themselves (Gilson 2009: 153). That is to say, the forms living beings assume are determined by mediate causes, such as the laws of heredity.

The concept of evolution as the manifestation of inherent possibilities recognises the observed variability of species, namely that the spatial and temporal appearance of any genus, species, or individual is always changing (Coomaraswamy 1989: 74). The Middle Platonic philosopher Plutarch reasoned in this regard that 'nobody remains one, nor is one; but we become (*gignometha*) many … and if he is not the same, we cannot say that he is, but only that he is being transformed as one self comes into being from the other … and it is only of God, in whose now there is neither future nor past, nor older nor younger, that we can say that He is' (quoted in Coomaraswamy 1989: 81). Therefore all definitions of categories like genus, species, and individual are indefinite, Coomaraswamy adds, since they refer to things that are always becoming. These are only 'things' if we ignore their variation in time, that is in the relatively short present. Ultimately every form of life is composite and hence mortal – only the beginning-less Life (i.e. God) is also endless (Coomaraswamy 1989: 73-74).

The recognition that the world of phenomena is always subject to becoming repudiates the oft-repeated claim that traditional metaphysics asserts a static world-order, which in the organic world entails a fixity of species. It has been suggested, for example, that for the Hellenic philosophers with their teleological world-view no change in species was believed to be possible, since the design of each species corresponds to an unchanging purpose. Accordingly, no new species could arise and there are no gaps in the biosphere to fill (Swift 2002: 59). It has also been argued that both Plato and Aristotle viewed the Form of an individual organism as more real than the variations between individuals. Since the Forms are eternal and unchanging, organic phenomena such as species are also conceived as fixed entities (MacNeill 2006). However, Plato held a dynamic view of the sensible world, depicting the realm of becoming as follows: 'It comes to be and passes away, but never really is' (*Timaeus* 28a); and 'What is really true, is this: the things of which we naturally say that they "are", are in process of coming to be, as the result of movement and change and blending with one another. We are wrong when we say they "are", since nothing ever is, but everything is coming to be' (*Theaetetus* 152d-e). Similarly, for Aristotle all things in the terrestrial realm are subject to alternate generation and decay, in accordance with natural laws (*Parts of*

Animals 644b; *On Generation and Corruption* 319a). And in the cosmology of Proclus we encounter a ceaseless interaction between Being and becoming, which is effected by the alternating motions of procession (*proodos*) from the One (*monē*) and return (*epistrophē*) to It.

Evoking the Platonic cosmology, Coomaraswamy argues that every visible form (*morphē*) of species or individuals reflects an archetypical possibility. Thus there is an invisible Sun, an Apollo, other than the visible sun, or Helios. This traditional doctrine is not monistic or dualistic, but descriptive of a reality that is both one in itself and many in its manifestations. Accordingly, God is conceived as omniform (*pantomorphos*), while the vast variety of life-forms melt into one another and cannot be precisely defined (Coomaraswamy 1989: 74, 75, 79). Again we encounter the notion of a differentiated unity, based in the divine Principle.

That the evolutionary process is none other than God 'opening out' Itself in various degrees of reality has been illustrated by James Cutsinger by means of the deployment of the point (representing the infinity of God) into the organic realm (2007: 16). Upon completing its third spatial deployment (i.e. from plane into solid), the point is present in a uniform way throughout a particular object, for example in the crystalline structure of a diamond. In order to increase its amplitude, the point then 'goes indoors', as it were. This interiorisation represents the beginning of organic life as it unfolds on the inside of matter, namely the plant kingdom. At this stage of the evolutionary process the function of specialisation appears for the first time, so that the parts become differentiated from the whole. In addition, the more inward character of biological processes provides the divine Subject with additional opportunities for expansion, as is evident in growth. However, although the plant is able to grow and blossom, it is still limited due to its attachment to the Earth. Thus in the next evolutionary stage the point interiorises further, giving rise to sentience and the power of locomotion, both of which characterise the animal kingdom (Cutsinger 2007: 16).

The metaphysical distinction between the First Cause and mediate causes also pertains to the theological doctrine of divine creation. Thus God is the First Cause that contains all possibilities, while He creates through indirect causes the conditions for the actualisation of the possibilities. In other words, God is the direct cause of the being of things, but only indirectly of their mode of existence. The latter is determined by the indirect causes, through which a species or individual manifests in space and time (Coomaraswamy 1989: 70-71). In the Patristic and Scholastic understanding this distinction between ultimate and secondary causes applies also to living beings, so that the original progenitor of every living species was formed directly by God and not through a chain of secondary causes. As explained by Wolfgang Smith: ‘Thus, according to this doctrine, living creatures can originate in two ways: through a primary or “vertical” mode of generation, which does not involve seed [i.e. procreation] as an intermediate cause; and through a secondary or “horizontal” mode, that is to say, by means of a natural process. But at the same time we must not forget that the natural process, no less than the primary generation, derives its entire efficacy from the power of God’ (2008: 89). The distinction between these modes therefore pertains to the realm of manifestation, while the ultimate cause (God) is the same in both cases.

The notion of indirect or secondary yet creative causes is also related to the concept of natural laws underlying the coming-to-be of the world and of living beings. According to Robert Chambers (in his epochal *Vestiges of the Natural History of Creation*, published in 1844) the formation of the solar system and the earth, as well as the emergence of life on earth, are due to the operation of natural laws which are analogous to gravitation in the physical world. These natural laws are established by God, and therefore the formative processes are the work of God acting through secondary causes (Swift 2002: 76). This recognition moreover implies that metaphysics, physics, and biology are interrelated fields of inquiry, as is indeed the case in Hellenic philosophy, notably that of Aristotle.

Since the whole cosmogonic process is grounded in God as ultimate Source, it is the divine Subject deploying Itself through matter as life and through life as sentience. However, this metaphysical understanding of evolution should be contrasted with Darwinian transformism, Cutsinger insists (2007: 18). There is no question of matter evolving into life, or life evolving into sentience; and almost needless to say, no evolution of amphibians into reptiles or of reptiles into birds. Rather, ‘The only evolution is that of the point, which is the Divine Self as Subject. The forms of existence through which It “passes”, in a strictly non-temporal and instantaneous way, do not themselves change, for they are the unalterable images of celestial ideas – the distinct and immutable shadows cast by the Divine Sun as It shines upon the eternal archetypes of Its myriad creatures’ (Cutsinger 2007: 18). This notion of God unfolding Itself in and through the evolutionary process was evoked more than two thousand years ago in the profound cosmogony taught by Diogenes of Apollonia: ‘But all these things (earth, water, air, fire, and all the rest of the things in the cosmos), being differentiated out of the same thing [i.e. God], come to be different things at different times and return into the same thing' (Fragment 2). In other words, the various stages of an evolutionary process in time are none other than the multiple states of a single, non-temporal Essence (Cutsinger 2007: 13). That is to say, the cosmos and all life in it comprise a many-in-One, or a differentiated Unity.

3: Presocratic cosmology

3.1 Introduction

Since Hellenic philosophy represents the Western branch of classical Indo-European thought, the Presocratic cosmology should not be viewed as *sui generis*. As a matter of fact, 'the ancient Hellenes considered themselves to be students of the much older Oriental civilizations' (Uzdavinys 2004: xvii). Furthermore, some of the most important strands in Hellenic philosophy have deep roots in Mesopotamian and Egyptian wisdom. These include notions such as the Orphic and Socratic immortality of the soul, the Pythagorean number theory, and even Plato's theory of Ideas. The Orphic teaching played a major role in the unfolding of Hellenic philosophy, and in its turn was derived from both Jainism (according to Alain Daniélou) and the Egyptian wisdom tradition (Uzdavinys 2004: xix, xxiii). The Hellenic indebtedness to Egyptian and Babylonian wisdom was in fact recognised by a number of Classical authors. For instance, Plutarch wrote that the wisest of the Greeks travelled to Egypt to learn from the priests, for example Solon at Sais and Pythagoras at Heliopolis. The Jewish historian Josephus remarked that the earliest among the Greeks to philosophise 'about things celestial and divine', including Thales and Pythagoras, received their learning from the Egyptians and the Chaldeans. And the Hellenic historian Diodorus Siculus asserted that according to the records of the Egyptian priests, they were visited by such luminaries as Homer, Pythagoras, Solon and Plato (Bailey 1994: 270-273).

A number of Hellenic thinkers of the centuries preceding Socrates, Plato and Aristotle were known as cosmologists or natural philosophers (Greek *physiologoi*), due to their focus on the origin and nature of the cosmos. These Presocratics (as they became known in modern scholarship) were concerned with observation of the environment, the mutations of natural elements and the cyclical natural processes (Theodossiou *et al* 2011: 93). Their work included the nature of physical substances, the number of ultimate kinds of thing, the existence of the void and the nature of temporal change (Blackburn 2008: 289). The earliest among these cosmologists, especially the Ionians, devoted their investigations mainly into the question of the *archē,* which means 'beginning, first cause, origin, first principle, or element' (L&S 106). It has been suggested by Oswald Spengler that the problem of the *archē* was the primary ontological question in Hellenic thought, in which the *archē* was understood as 'the material origin and foundation of all sensuously perceptible things' (1991: 94). Consequently the origin of the cosmos was to be found in one or more of four *archai* (the plural of *archē*): earth, water, air, and fire. These first principles later became known as elements, and since the elements are material principles, *archē* could also be translated as primeval or primary matter (Dreyer 1975: 27-28). This notion became the Latin concept of *materia prima*, denoting the indeterminate common nature that requires a specific principle or form to determine the substance that exists at any time (Blackburn 2008: 225). In other words, primary matter is devoid of substance until it is determined by form.

However, we contend that the modern view of the Presocratic *archai* as signifying material elements only is erroneous. Frithjof Schuon, for instance, emphasised that Thales had in mind the universal Substance (or *Prakriti* in Indian philosophy) as the *archē*, and not the sensible element of water. The same applies to the 'air' of Anaximenes and the 'fire' of Heraclitus (Schuon 1984: 71). This metaphysical understanding of first principles is reflected in the *Bhagavad Gita*, where we find Krishna expounding the nature of reality to Arjuna: 'Earth, Water, Fire, Air, Ether, Mind, Reason, and Ego – thus eightfold is my *Prakriti* divided. This is my lower aspect; but know thy my other aspect, the higher – which is *Jiva* (the Vital Essence) by which, O Mahabahu, this world is sustained' (Discourse 7, *Jananvijnana Yoga*; Gandhi's translation). Therefore Aristotle either misunderstood or misrepresented the Presocratics when he charged them with attempting to explain causality only in terms of matter: 'Of the first philosophers, then, most thought the principles which were of the nature of matter were the only principles of things' (*Metaphysics* I.III, 983b). Thales, Anaximenes, Diogenes, Heraclitus, Empedocles and Anaxagoras are mentioned by Aristotle in this regard.

3.2 The Milesians

The earliest Presocratic thinkers are generically grouped as the Milesians, since they hailed from the Ionian city of Miletus: Thales, Anaximander, and Anaximenes. They are for the same reason also known as Ionian philosophers, together with Heraclitus of Ephesus (another Ionian city). The pioneer of Western cosmology in the philosophical sense is Thales, who lived around 624 to 546 B.C. and was revered as one of the Seven Sages of ancient Greece. He recorded an eclipse which has been dated to 585 B.C., an event that has come to symbolise the beginning of Hellenic natural philosophy (Ferguson 2011: 16). According to Aristotle, Thales viewed water (*hydor*) as the *archē*, the fundamental principle from which everything comes to be (*Metaphysics* I.3, 983b). Accordingly, all physical entities are produced through transformations of water. While the expansion and evaporation of water created the air, its contraction and condensation produces the element of earth. Thus from water all things arise and to water they eventually return (Theodossiou *et al* 2011: 94). However, Aristotle also mentions the view of certain people that soul is intermingled in the whole universe, and he speculates that this may be the reason for Thales' view that all things are full of gods (*On the Soul* I.5, 411a). The latter notion follows from the postulate that water is a life force with no beginning or end in time, and therefore has to be divine (McKirahan 1994: 31). It appears that for Thales there is in principle no distinction between the living and the inanimate, so that the psychic and the material are essentially conflated to one level of reality (Dreyer 1975: 29). Combining these arguments, it becomes clear that Thales viewed water as symbolising universal Substance, and not only as a material element.

Traditionally viewed as Thales' successor in the study of nature, Anaximander (around 610-547 B.C.) is credited for introducing the gnomon (or sundial) to Greece, which was probably obtained from the Babylonians (McKirahan 1994: 32). In Anaximander's metaphysics the universal Substance underlying the phenomenal world is clearly depicted in non-material terms. According to the Aristotelian commentator Theophrastus, 'Anaximander … said that the *apeiron* was the *archē* and element of things that are, and he was the first to introduce this name for the *archē* … He says that the *archē* is neither water nor any other of the things called elements, but some other nature which is *apeiron*, out of which come to be all the heavens and the worlds in them. This is eternal and ageless and surrounds all the worlds' (quoted in McKirahan 1994: 33-34). The term *apeiron* is a compound of the prefix *a* (not) and the nouns *peirar* or *peras* (end or extremity), and thus signifies that which is boundless or endless (L&S 80). It appears that for Anaximander the *apeiron* means spatially and temporally unlimited, and an indefinite kind of material (McKirahan 1994: 34). In other words, the *apeiron* has no specific properties, has no origin or cessation, and is inexhaustible (Dreyer 1975: 29). Since the *apeiron* is eternal and in motion, it has to be conceived as divine, as has been affirmed by Aristotle (*Physics* III.4.203b). It has been asserted by Oswald Spengler that Anaximander's notion of the *apeiron* is the deepest concept of Hellenic metaphysics. It possesses no number (in the Pythagorean sense of the word) and hence no being. The *apeiron* is 'the measureless, the negation of form, the statue not yet carved out of the block; the *archē* optically boundless and formless, which only becomes a something (namely, the world) after being split up by the senses.' As such the *apeiron* is also the underlying form of cognition in the Hellenic conception (Spengler 1991: 47).

The interaction between generation and destruction is evoked in the only extant fragment of Anaximander, as quoted by Simplicius: ‘The things that are perish into the things out of which they come to be, according to necessity, for they pay penalty and retribution to each other for their injustice in accordance with the ordering of time, as he says in rather poetical language’ (McKirahan 1994: 43). It appears that for Anaximander there exists a cosmic justice (*dikē*; also meaning order, law, and right: L&S 173), that maintains the balance among the four principal elements of water, earth, air and fire. This process probably applies to the opposites of hot and cold, as manifested in the alternation of the four seasons, as well as in the rhythm of day and night. Moreover, in this fragment we encounter an anticipation of notions such as the conservation of matter and of dynamic equilibrium among opposing principles (McKirahan 1994: 44-45).

The last of the trio of Milesian cosmologists was Anaximenes, who flourished around 546 B.C. and died around 525 B.C. He was a pupil of Anaximander and familiar with the teaching of Thales. According to the testimony of Theophrastus and Simplicius, ‘Anaximenes … declares that the underlying nature is one and *apeiron*, but not indeterminate as Anaximander held, but definite, saying that is *aēr* (air). It differs in rarity and density according to the substances it becomes. Becoming finer it comes to be fire; being condensed it comes to be wind, then cloud, and when still further condensed it becomes water, then earth, then stones, and the rest come to be out of these’ (quoted in McKirahan 1994: 48). In other words, the elements are produced from air through a process of rarefaction and condensation, which in turn produce all the other phenomena (Dreyer 1975: 31). This notion of Anaximenes has been viewed by some modern scholars as representing the first physical account in Western thought of different substances as modifications of one primary substance (Blackburn 2008: 15). However, air is conceived by Anaximenes as infinite, eternal, and constantly moving (Theodossiou *et al* 2011: 95). Air is therefore divine, like the water of Thales and the *apeiron* of Anaximander, so that it is more feasible to conceive the *aēr* of Anaximenes as symbolising universal Substance than indicating the material element only.

It should be noted that in the works of Homer and Hesiod the Greek term *aēr* denoted the lower atmosphere surrounding the Earth, in contrast to the purer upper air of the heaven, the *aithēr* (L&S 15, 18-19). From Anaximenes onwards, *aēr* became associated with the air that we breathe (McKirahan 1994: 49-50). Anaximenes argued that just as humans are permeated by soul, so the cosmos is permeated by air. The only surviving fragment of Anaximenes reads as follows: ‘Just as our soul, being air, holds us together and controls us (*synkratein*), so do breath and air surround the whole cosmos’ (quoted in McKirahan 1994: 54). This implies that air, soul, and life are in principle identical. Even the gods are generated by air, Anaximenes asserted, and not the other way around (Dreyer 1975: 32). Evidently this thinker held a non-reductionist view of the natural world, in which the presence of soul (*psychē*) is taken for granted.

By postulating one element as the basis for everything in the cosmos, the Milesian thinkers (as well as their fellow Ionian, Heraclitus) pioneered a unifying approach for the physical world. In this way they opened new paths for the study of nature by means of logical thought (Theodossiou *et al* 2011: 89-90). Yet their logic remained grounded in the metaphysical tradition, as would be the case with most of their Hellenic successors. Moreover, since the Ionian philosophers ascribed divinity to their *archai* (whether water, air, fire, or the infinite), they laid the foundations of theistic cosmology in Western thought.

3.3 Pythagoras and the Pythagoreans

One of the most influential Hellenic philosophers, Pythagoras of Samos (around 582-496 B.C.), has traditionally been honoured as the father of Western mathematics. According to his biographers, Pythagoras studied with both Thales and Anaximander, of which the former encouraged him to study in Egypt (Ferguson 2011: 16-17). He consequently devoted himself to studying geometry, arithmetic, astronomy and theology during his lengthy residence in Egypt. According to the rhetorician Isocrates (fourth century B.C.), it was Pythagoras who first brought Egyptian philosophy to the Hellenic lands (Uzdavinys 2004: xvi).

It has been suggested by Kitty Ferguson that Pythagoras acquired various strands of his theistic cosmology at different temples mentioned by Porphyry in his biography. Thus at Heliopolis he might have learnt that the diversity of nature arose from a single source, namely the god Atum (meaning ‘All’), which bears a similarity to the *apeiron* of Anaximander. At Memphis the priests could have instructed him of the role played by the god Ptah as divine intermediary between the mind of the Creator and the act of physical creation, analogous to the Hellenic (and Christian) Logos. Finally, he was initiated into the Egyptian mysteries at Thebes, where the supreme god was Amun (meaning ‘Hidden’), the unknowable and transcendent, of which the other gods were manifestations (Ferguson 2011: 23-24).

It is noteworthy, given the popular notion that polytheism predated monotheism, that the Egyptian doctrine on the supreme creator God, Ptah, dates from the very beginning of Egyptian history. As commented by Mircea Eliade, the earliest Egyptian cosmogony is also the most philosophical: "For Ptah creates by his mind and his word... In short, the theogony and cosmogony are effected by the creative power of the thought and word of a single God... It is *at the beginning* of Egyptian history that we find a doctrine that can be compared with the Christian theology of the Logos" (quoted in Damascene 2004: 221).

According to Iamblichus, after twenty-two years in Egypt Pythagoras spent a further twelve years studying in Babylon before returning to Samos. Around 531 B.C. Pythagoras emigrated to Croton in southern Italy, where he founded a religious-philosophical society comprising men and women on an equal standing. However, it was violently suppressed thirty years later and Pythagoras was either killed or exiled to Metapontum. The first book of Pythagorean thought was written during the second half of the fifth century B.C. by Philolaus in Thebes (Ferguson 2011: 33, 42, 72-75, 102). Biographies of Pythagoras were compiled in the third and early fourth centuries A.D. by Diogenes Laertius, Porphyry and Iamblichus.

As was the case with Socrates, Pythagoras wrote nothing (as far as is known) and yet made a lasting contribution to Western thought. According to the early Christian historian Eusebius, Pythagoras invented the term ‘philosophy’, wishing to be called a lover of wisdom, or *philosophos* (Bailey 1994: 274). Interestingly, the celebrated geometrical theorem attributed to Pythagoras (i.e. that the square on the hypotenuse of a right-angled triangle is equal in size to the sum of the squares on the other two sides) was already known in Mesopotamia and Egypt by the second millennium B.C. (Ferguson 2011: 78-84). We have already noted that Pythagoras undertook intensive studies in precisely these lands. Pythagoras is also credited with being the first Western thinker to postulate a spherical Earth, on the grounds that the sphere is the most perfect shape for a solid body. This notion would be supported by Aristotle and other Hellenic thinkers, but with the rise of the Roman Empire the hypothesis of the spherical Earth became replaced with the flat Earth doctrine (Theodosiou *et al* 2011: 92-93).[7]

The point of departure for Pythagorean philosophy was the discovery that concordant musical intervals can be expressed mathematically. To be more precise, ‘the first natural law ever

7 The Roman Empire was the Classical equivalent of the contemporary American Empire, both characterised by aggressive militarism and obsessive legalism, to the detriment of philosophy and ultimately truth itself.

formulated mathematically was the relationship between musical pitch and the length of a vibrating harp string' (Ferguson 2011: 62). Pythagoras and his students noticed that certain ratios of string lengths always produce the harmonic intervals of the octave (2:1), the fifth (3:2) and the fourth (4:3). The sum of these four numbers (1+2+3+4) is the sacred number ten, the *tetraktys,* meaning 'fourness'. This scheme is geometrically represented by four rows of pebbles arranged from four at the base to one at the summit, thus forming an equilateral triangle consisting of ten pebbles. It was also discovered by the Pythagoreans that a tetrahedron, or four-sided solid, could be constructed out of four equilateral triangles (Ferguson 2011: 65, 69). The significance of the first four numbers is again evident herein.

These discoveries by Pythagoras and his associates had revolutionary implications for cosmology: (a) qualitative notions (such as sound) could henceforth be expressed in quantitative terms; (b) number took precedence over matter; and (c) mathematical accounts of phenomena came to be preferred over descriptions in terms of physical constituents (McKirahan 1994: 91, 92). In this way Pythagoras initiated the mathematical interpretation of nature, which in turn gave rise to his doctrine of the harmony of the spheres, in which mathematics, music and astronomy are fused together. The Pythagorean cosmology is thus based on a different (but not contradictory) approach than the Ionian striving to ground physics in terms of an undifferentiated *archē* that is shared by all things. By instead focusing on form, physical natures are provided with an intelligible grounding in different geometrical structures (Blackburn 2008: 300). This notion anticipates Plato's and Aristotle's insistence on the priority of form over matter in the constitution of physical reality.

Pythagoras is credited with being the first thinker to apply the meanings of the term *kosmos* as orderly arrangement and ornament or adornment to the universe (McKirahan 1994: 92; Critchlow 2010: 5). This is related to the term *harmonia*, which originally meant joining or fitting together (as in Homer's *Odyssey*; Ferguson 2011: 107). Later *harmonia* came to signify the string of a lyre and its tuning or scale. Accordingly, *kosmos* depends on *harmonia*, while the latter is based on number. According to Sextus Empiricus, the Pythagoreans viewed the *tetraktys* as the source of ever flowing nature, since the entire cosmos is arranged according to *harmonia*, and the latter is a system of three concords (i.e. the harmonic intervals of the octave, the fifth, and the fourth). In this way the structure of the universe is explained in terms of the first four whole numbers (McKirahan 1994: 93). The Pythagorean teaching on the priority of number can be summarised as follows: number is fundamental to all things; the basic features of all things are numerical; numerical considerations are basic in understanding all things; and all things are generated in a similar way to numbers (McKirahan 1994: 112).

Aristotle affirmed that the Pythagoreans supposed the elements of numbers to be the elements of all existing things, including the heaven (*Metaphysics* I.5, 985b-986a). Initially a relation is established between numbers and geometry, with the basic entity in these realms being the unit (*monas*), i.e. a point lacking position, and the point (*stigmē*), i.e. a unit having position, respectively. Therefore numbers are pluralities of units, while lines, planes, and solids are extensions of points into one, two, and three dimensions, respectively (McKirahan 1994: 100). In his commentary titled *On Pythagorean Numbers*, Plato's nephew Speusippus (and his successor at the Academy) asserted that ten (i.e. the decad) is the perfect number. It contains an equal amount of odd and even numbers, and of prime and composite numbers. Moreover, the decad consists of the primary elements in plane and solid figures: point, line, triangle, and pyramid. In terms of increasing magnitude, the generation of geometrical figures thus occurs as the point, the line, the surface, and the solid (Waterfield 1988: 112-114). Strictly speaking, the term 'tetrahedron' is more accurate than 'pyramid' in this context, since some pyramids have five surfaces. An example of the latter is the Great Pyramid of Giza, which Pythagoras in all likelihood visited, comprising a square base and four triangular sides (Ferguson 2011: 69).

Furthermore, for the Pythagoreans each of the four basic elements is derived from a particular geometrical figure. According to Aetius (second century A.D.), Pythagoras taught that earth is made from the cube, fire from the pyramid, air from the octahedron and water from the icosahedron, while the sphere of the whole is made from the dodecahedron. These shapes would have been familiar to the early Pythagoreans from both natural and artificial constructions: cubes and pyramids were often used in building, and various kinds of crystal appear as cubes, octahedra or dodecahedra (Ferguson 2011: 155-156). Remarkably, these five regular solids (i.e. cube, pyramid, octahedron, icosahedron and dodecahedron) are the only geometrical solids in which all edges are equal, since all their faces are congruent and equilateral, and all their vertices form equal solid angles (McKirahan 1994: 102). In this way the physical nature of the universe is accounted for in terms of basic kinds of matter, while these are analysed in terms of a finite number of simple geometrical bodies.

As far as ontology is concerned, Pythagoras and his followers realised the importance of the quantitative aspect of being (Dreyer 1975: 35). Moreover, the Pythagorean numerology implies a distinction between the formal and the material, representing the first appearance of this fundamental metaphysical insight in Hellenic thought. In other words, matter as such is nothing, only when bounded does it assume form and become something (since form is the expression of limitation). Being is thus made possible through the unity of matter and form (Dreyer 1975: 38). It was argued in this regard by Philolaus that the fundamental principles of the limitless (*apeiron*) and the limiting (*peras*) have to be ‘locked together’ by *harmonia* in order to produce the world of differentiation. Harmony is accordingly a Pythagorean first principle (*archē*), and perhaps the most fundamental one (Ferguson 2011: 106-107).

In the religious-philosophical brotherhood founded by Pythagoras, the celebrated *Quadrivium* (Latin for *Tetraktys*) was first taught in the Western world. According to the *Theology of Arithmetic* attributed to Iamblichus, the conceptual foundation of these four mathematical sciences was that number is the form of things, with the first four numbers containing the roots and elements of all number (Waterfield 1988: 56). The *Quadrivium* entailed the study of the following subjects: (i) arithmetic, dealing with number as such; (ii) geometry, which is number in space; (iii) music, which is number in time; and (iv) astronomy/cosmology, which is number in space and time. Through these studies the practitioner strove to return his or her soul to the source thereof, which is the One. For instance, through studying the perfection and harmony of the heavens, the movements of one’s own soul could be perfected. Among the numerous students of the *Quadrivium* count such illustrious figures of the Western metaphysical tradition as Plato, Aristotle, Euclid, Cicero, Philo of Alexandria, Clement of Alexandria, Origen, Plotinus, Iamblichus, Dionysius the Areopagite, Al-Kindi, Eriugena, Avicenna, Hildegard of Bingen, Thomas Aquinas, Dante and Kepler (Critchlow 2010: 3-5).

According to Porphyry’s biography, Pythagoras was the first Hellenic thinker to teach that the human soul is immortal (*athanatos*), that it can change into other kinds of animals, and that all living beings are related (McKirahan 1994: 84). In the brotherhood founded by Pythagoras the study of music and mathematics was a necessary activity for purification (*katharsis*) of the soul (Dreyer 1975: 35). Such purification was believed to facilitate the movement of the soul towards union with the Godhead, since pure souls have the best afterlife. Purification was obtained not only physically (e.g. abstaining from meat), but especially by gaining knowledge through the study of mathematics and the *kosmos*. The numerical basis of the latter facilitates its comprehension by humans – in other words, the human soul becomes orderly (*kosmiōs*) when it understands the order (*kosmos*) in the universe (McKirahan 1994: 114).

Finally, anticipating the Neoplatonic doctrine that the divine Intellect creates the world through the World-Soul, the Pythagoreans held the following notion: ‘They declared intellect and essence to be the one, since he spoke of the soul as the intelligence. They said that because it is stable and similar in every way and sovereign, the intelligence is the unity and one’ (Alexander Polyhistor, *Commentary on Aristotle’s Metaphysics*; quoted in McKirahan 1994: 109). The origin of number and hence of the cosmos, which is the One, is thus related to intellect and soul, through which the One gives rise to the many.

3.4 Heraclitus

Born into an aristocratic family, Heraclitus of Ephesus (around 535-475 B.C.) achieved lasting philosophical and theological relevance with his dynamic conception of physical reality and his Logos doctrine. In addition, the Ionian thinker was known for the obscurity of his prose, so that he eventually became referred to as *ho skoteinos*, the dark one (Dreyer 1975: 40). It has been remarked that Heraclitus is not a typical *physiologos*, since he was too much of a mystic, a poet and a metaphysician. Nonetheless, Gregory Vlastos affirms, he was more than a cosmologist, rather than less (1975: 4). Heraclitus was a contemporary of the Chinese philosopher Lao Tzu, and there are striking similarities between their respective teachings, notably on the Logos and the Tao (Damascene 2004: 29-32).[8] The following fragments of Heraclitus are relevant to our thesis:[9]

‘This *logos* holds always but humans always prove unable to understand it, both before hearing it and when they have first heard it. For though all things come to be in accordance with this *logos*, humans are like the inexperienced when they experience such words and deeds as I set out, distinguishing each in accordance with its nature and saying how it is’ (1).
‘For this reason it is necessary to follow what is common. But although the *logos* is common, most people live as if they had their own private understanding’ (2).
‘What is opposed brings together; the finest harmony (*harmonia*) is composed of things at variance, and everything comes to be in accordance with strife’ (8).
‘The *kosmos*, the same for all, none of the gods nor of humans have made, but was always and

[8] The equivalence of the Logos and the Tao has been recognised by translators of the New Testament into Chinese, so that the Gospel of John commences thus: ‘In the beginning was the Tao, and the Tao was with God, and the Tao was God... And the Tao became flesh, and dwelt among us’ (Damascene 2004: 8).

[9] The fragments quoted in this chapter have been obtained from the translation by Richard McKirahan (1994), unless otherwise indicated.

is and shall be: an ever-living fire being kindled in measures and being extinguished in measures' (30).
'The turnings of fire: first, sea; and of sea, half is earth and half fiery waterspout … Earth is poured out as sea, and is measured according to the same ratio (*logos*) it was before it became earth' (31).
'You would not discover the limits of the soul although you travelled every road: it has so deep a *logos*' (45).
'Listening not to me but to the *logos* it is wise to agree that all things are one' (50).
'They do not understand how, though at variance with itself, it agrees with itself [or, more literally, how being brought apart it is brought together]. It is a backwards-turning [or, backwards-stretching] attunement like that of the bow and the lyre' (51).
'God is day and night, winter and summer, war and peace, satiety and hunger, but changes the way [fire], when mingled with perfumes, is named according to the scent of each' (67).
'It is necessary to know that war is common and justice is strife and that all things happen in accordance with strife and necessity' (80).
'Those who speak with understanding must rely firmly on what is common to all as a city relies on law and much more firmly. For all human laws are nourished by one law, the divine law; for it has as much power as it wishes and is sufficient for all and is still left over' (114).

Being related to the verb *legō*, meaning I relate, speak, or say, the noun *logos* primarily means the word by which the inward thought is expressed and also the inward thought or reason itself. From this basis further meanings of 'word', 'story' or 'reason' are derived (L&S 408, 416). From Fragments 1 and 2 we can deduce the meaning of the *logos* for Heraclitus, namely that it is constant; it unfolds as the 'together' in beings; and everything that happens is in accordance with this constant 'together' (Heidegger 2000: 135). Due to the presence of the *logos*, reality displays both unity and plurality. The activity of the *logos* guarantees that all things are one and one thing is all (McKirahan 1994: 134-135). Evidently, for Heraclitus the *logos* is the link between the one and the many, that is to say, between cosmic unity and diversity. Stated in metaphysical terms by Frithjof Schuon (1982: 37), the Logos contains all the archetypes and thereby translates the Potentiality of the Essence (Spirit, *Purusha*) into an inexhaustible unfolding of possibilities.

It appears that Heraclitus conceived the *logos* as providing a hermeneutical key for understanding the whole of reality. Understanding the *logos* is therefore the most important of all human activities. The *logos* is said to be common because it applies everywhere and is an objective reality (McKirahan 1994: 130, 133). It was averred by Martin Heidegger that although *logos* and *legein* (to speak) are related, discourse is not the essence of *logos,* which is rather the 'gatheredness of beings themselves.' In other words, *logos* is the constant gatheredness of beings that stand in itself, i.e. Being, and therefore *physis* and *logos* are the same (Heidegger 2000: 137-138). However, in the Hellenic conception language serves as a reflection of reality, as is suggested by the etymological link between *logos, legō* and *legein*. The *logos* thus entails both epistemological and ontological dimensions, with the former deriving its reality from the latter. That is to say, the *logos* is both the first principle of knowledge and the first principle of existence (Damascene 2004: 30). Moreover, since reality is complex (Fragment 123: 'Nature loves to hide'), one finds an explanation for the Ephesian philosopher's celebrated predilection for paradoxical expressions (McKirahan 1994: 133).

Heraclitus has often been credited with teaching that all existing things are in a state of flux. For instance, in Plato's epistemological dialogue *Theaetetus* Socrates mentions a theory held by Heraclitus (as well as Protagoras and Empedocles) that all things are in flux and motion, so that nothing is stationary (152e, 156a, 179e). This notion is expressed in Greek as *panta rei*: 'everything flows.' One cannot step into the same river twice, Heraclitus argued, for different waters are always flowing in it (Fragments 12 and 91). Therefore, in the phenomenal world nothing *is,* but everything *becomes* (Dreyer 1975: 41). It has even been suggested that Heraclitus anticipated quantum physics with his teaching that the apparent stability of the natural world is an illusion of our senses (Theodossiou *et al* 2011: 90).

However, not all commentators accept this 'conventional' view of Heraclitus. Instead it appears that the Ionian philosopher values equally change and stability, plurality and unity, and difference and identity – according to which one pole implies the existence of the other (McKirahan 1994: 142). This reading is confirmed by Fragment 8, for example, on the harmony of opposites. In fact, Richard McKirahan remarks, without differentiation there would be no harmony, since harmony is a relation among different things (1994: 134). For Heraclitus the cosmos consists of pairs of opposites that are continuously interacting. This interaction has a theistic dimension, as suggested in Fragment 67 where we are told that God is related to various pairs of opposites. As commented by Reginald Allen, 'This unity lies beneath the surface, for it is a unity of diverse and conflicting opposites, in whose strife the Logos maintains a continuous balance... The Logos maintains the equilibrium of the universe at every moment' (quoted in Damascene 2004: 31).

Heraclitus conceived the first principles of the cosmos to be fire, water, and earth. Interestingly, he omits air, which had figured so prominently as *archē* in the thought of some of his Ionian predecessors. Among the three elements fire is granted priority by Heraclitus, on account of its active and controlling role in the cosmos. Likewise in the human individual the soul gives life and direction to its bearer, and therefore fire and soul are used interchangeably. Fire is also identified with the *logos*, according to which all things happen (McKirahan 1994: 138-140, 144). It is clear that Heraclitus did not conceive of fire in the material sense only, but primarily in the metaphysical sense. However, since the *logos* is the cosmic regulator and divine lawgiver, we contend that it would be more correct to view fire as symbol of the active, universal Essence (*Purusha*) rather than the passive, universal Substance (*Prakriti*) that underlies the realm of Manifestation.

According to the cosmology of Heraclitus, the cosmos develops by means of a progression from fire to water and from water to earth, as we read in Fragment 31. These three elements are continuously being transformed into one another, and therefore each of them is always coming to be and perishing. For Heraclitus it is precisely the regularity of the mutual mutations of the elements that guarantees the stability of the cosmos (McKirahan 1994: 139). Furthermore, the cosmos is viewed as eternal and therefore uncreated (Fragment 30). According to Hierotheos Vlastos (1975:6), this is the first appearance in Hellenic thought of a cosmology without a cosmogony. However, this interpretation should be balanced with the notion of the *logos* as cosmic regulator and lawgiver.

Contrary to the view held by Anaximander that the interaction between opposites brings about injustice, Heraclitus asserts that the active nature of universe is war and strife, which brings about justice. To humans strife appears destructive, but in reality strife is responsible for the generation of things (McKirahan 1994: 134-135). For Heraclitus the cosmic order is symbolised by the lyre and the bow (Fragment 51), being respectively the musical instrument and weapon of the god Apollo. Whereas the bow symbolised strife, the lyre signified *harmonia*. Heraclitus was the first Hellenic thinker to emphasise the cosmic significance of strife, but the notion of cosmic harmony was obtained from the Pythagoreans (Ferguson 2011: 90-91). One should therefore not attach too much weight to the Ephesian's criticism of Pythagoras as a polymath without insight and guilty of evil trickery (Fragments 40 and 129).

Before Heraclitus the human soul (*psychē*) was generally viewed as composed of air and functioning as life-giver to the body it inhabits.[10] At death the soul departs from the body to rejoin the cosmic air, or, in the teaching of the Pythagoreans, to transmigrate into another body. Heraclitus went further than his predecessors in integrating his understanding of the soul with his cosmology (McKirahan 1994: 146). Thus the soul is the fire that directs us, just as the cosmic fire steers all things. Heraclitus was also the first Western thinker to ascribe cognitive functions to the human soul, which understands and interprets sense impressions. The latter is done correctly when phenomena are understood as manifestations of the *logos* (McKirahan 1994: 147).

According to the testimony of Sextus Empiricus, Heraclitus connected intelligence (*nous*) with the *logos*, since what surrounds us is rational (*logikos*) and intelligent (*noetikos*). In this conception, humans become intelligent by drawing in the divine *logos* through breathing (McKirahan 1994: 146, 147). This notion implies that human intelligence is dependent upon the indwelling presence of the *logos*, through which humans participate in the Divinity. In view of the above-mentioned arguments, we suggest that the *Logos* of Heraclitus, symbolised by fire, is none other than the divine Intellect of Platonic theology, symbolised by the sun.

3.5 Parmenides

A complementary and equally influential philosophy was presented by Heraclitus' younger contemporary Parmenides (around 515-440 B.C.), who hailed from Elea in southern Italy. This town was also known as Velia, where Greeks fleeing the Persian conquerors in western Anatolia had founded a colony around 540 B.C. (Kingsley 2003: 17). Parmenides left behind a didactic poem in which he relates how an unnamed goddess instructed him in the Way of Truth (*alētheia*) and the contrasting way of opinion (*doxa*), which is actually falsehood (Dreyer 1975: 44). The poem consists of three parts: a Prologue with an announcement by the goddess; the Way of Truth; and the way of mortal opinion (McKirahan 1994: 158). The prologue apparently recounts a mystical experience by Parmenides, which McKirahan (1994: 159) suggests refers to his discovery of the 'divine power' of logic, since in a deductive argument the conclusion follows inevitably from the premises, and is thus beyond human power. However, according to Peter Kingsley (2003: 24, 29-31) the prologue depicts a

[10] The Greek noun *psychē* also means breath, life, or spirit, as the equivalent of the Latin *anima* (L&S 798).

spiritual journey by Parmenides while in state of death-like sleep, and is wholly unrelated to logic which is only discussed in the second part of the poem. Consequently, the whole Eleatic school of philosophy, beginning with Parmenides, is rooted in mysticism (Uzdavinys 2011: 65), and not in rational speculation.

Parmenides became the first Western thinker to clearly differentiate between that which is and that which is not, that is to say, between being and non-being. In the Way of Truth the realm of being is depicted as follows: 'There is still left a single story of a way, that it is. On this way there are signs exceedingly many – that being ungenerated it is also imperishable, whole and of a single kind and unshaken and complete. Nor was it ever nor will it be, since it is now, all together, one, continuous. … What necessity would have stirred it up to grow later rather than earlier, beginning from nothing?' (Fragment 8). This understanding of being is contrasted with the way of opinion: 'In this way, according to opinion, these things have grown and now are and afterwards after growing up will come to an end. And upon them humans have established a name to mark each one' (Fragment 19). Another fragment of Parmenides that is mentioned by both Plato and Simplicius affirms that 'Such [or Alone], unchanging, is that for which as a whole the name is "to be"' (quoted in McKirahan 1994: 157). Thus the Eleatic thinker introduces the one true reality, which is contrasted with the appearances of things arising through the opposition of equally unreal forces, namely light and darkness ('very light' opposed to 'dark night', Fragment 8; Blackburn 2008: 267).

In spatial terms, for Parmenides being is filled space (*to pleon*), whereas non-being is empty space (*to kenon*). The ultimate reality that is being is characterised by the following (Dreyer 1975: 44-45): (i) being is without origin or cessation, since it could only arise from or return to non-being, which does not exist; (ii) being is one whole, in other words a homogeneous continuity; therefore it cannot be divided into parts; (iii) being is motionless, since motion requires empty space, and the latter is equivalent with non-being, which does not exist; and (iv) being is perfect, since any deficiency would imply the existence of non-being, which is impossible. It appears that Parmenides' ontology of cosmic unity is based on the Orphic tradition. The grounding of the many in the one is strikingly depicted in one of the Orphic poems: 'From the whole are all things, all things from a whole, all things are one, each part of all, all in one; for from a single whole all these things came, and from them in due time will one return, that's ever one and many... All dies that's mortal, but the substrate was and is immortal ever, fashioned thus' (quoted in Uzdavinys 2011: 64).

Parmenides also distinguishes between being and becoming, in which being is the object of knowledge while becoming is the object of opinion (Curd 2011). In fact, there is a confluence of true being and true knowledge: ‘For the same thing is [or, is there] for thinking and for being [or, For thinking and being are the same]’ (Fragment 3). However, the world of sense perception cannot be the object of knowledge, since it only appears to be real. As the goddess depicted the realm of becoming to her Eleatic devotee: ‘wherefore it has been named all names [or, all things] mortals have established, persuaded that they are true – to come to be and to perish, to be and not to be, and to change place and alter bright colour’ (Fragment 8). It thus appears that Parmenides was conscious of the conflict between reason and sense perception, and the illusory nature of the latter (Blackburn 2008: 268).

The philosophy of Parmenides marks a turning point in the history of Western thought: he was the first to introduce deductive arguments into philosophy; the first to undertake explicit philosophical analyses of concepts such as being, coming to be, change, motion, time and space; and the first to use these concepts to analyse the nature of the logical subject, so that he can also be regarded as the father of Western metaphysics (McKirahan 1994: 157). In this way the Eleatic thinker articulated the epistemological and ontological categories that became fundamental to Platonism (Uzdavinys 2011: 73). One should, however, keep in mind that Parmenides worked within the Indo-European metaphysical tradition, as did his Hellenic predecessors. He was in fact a younger contemporary of the Buddha in India, with his metaphysics showing a remarkable resemblance to Vedantic thought (Krüger 2007: 142). There can be no doubt that Parmenides would have rejected any claim to ‘originality.’ As aptly remarked by Francis Yockey, the craze for originality is a manifestation of decadence, and the decadence of civilization is the ascendancy of barbarism (1962: xlv).

3.6 Anaxagoras

Regarded together with Empedocles as a metaphysical pluralist, Anaxagoras of Clazomenae (around 500-428 B.C.) was the first known philosopher to teach in Athens. Like Parmenides he taught that reliance should not be placed on sense perception as a guide to knowledge: ‘On account of their [the senses’] feebleness we are unable to discern the truth’ (Fragment 21). Instead of declaring a particular element to be the first principle (*archē*), this remarkable thinker postulated an infinite number of elements as first principles, as we are told by Aristotle (*Metaphysics* I.3, 984a). Each of these elements (for example water, gold or blood) is identical in all its parts, Anaxagoras held. On the one hand he agreed with Heraclitus on the multiplicity of beings; that is to say, being can be divided. On the other hand he agreed with Parmenides that non-being does not exist, which implies that each element is eternal. Therefore, Anaxagoras reasoned, each element is infinitely divisible into minute particles, named *chremata* ('things') or *spermata* ('seeds'). Some quality of each *sperma* is to be found in all other *spermata*, but its own properties remain dominant (Dreyer 1975: 53).

According to Anaxagoras there was an original state in which all things were mixed: 'All things were together, unlimited in both amount (*plethon*) and smallness. For the small, too, was unlimited. And when (or, since) all things were together, nothing was manifest on account of smallness' (Fragment 1). Then an external force, the *nous* (translated as 'mind' or 'thought': L&S 467), worked in upon the primeval mass of *spermata*. The following fragments of Anaxagoras describe the role of Mind, or Intellect, in the cosmic processes:
'In everything there is a portion of everything except Mind, but Mind is in some things too' (11).
'The rest have a portion of everything, but Mind is unlimited and self-ruled and is mixed with no thing, but is alone and by itself. … For it is the finest of all things and the purest, and it has all judgement about everything and the greatest power. And Mind rules all things that possess life – both the larger and the smaller. And Mind ruled the entire rotation, so that it rotated in the beginning. ... And Mind knew all the things that are being mixed together and separated off and separated apart. And Mind set in order all things, whatever kinds of things were to be – whatever were and all that are now and whatever will be – and also this rotation in which are now rotating the stars and the sun and the moon, and the air (*aēr*) and aether (*aithēr*) that are being separated off … and nothing is being completely separated off or separated apart one from another except Mind. All Mind is alike, both the larger and the smaller' (12).
'And when Mind began to cause motion, separating off proceeded to occur from all that was moved, and all that Mind moved was separated apart, and as things were being moved and separated apart, the rotation caused much more separating apart to occur' (13).
'Mind, which is always, is very much even now where all other things are too, in the surrounding multitude and in things that have come together in the process of separating and in things that have separated off' (14).

These fragments of Anaxagoras' prose work, *Physica* ('Studies of Nature'), depict the cosmos as having a beginning (McKirahan 1994: 201). The philosopher thus diverges from the cosmology of Heraclitus and Parmenides, in terms of which the universe exists eternally. It appears further that Anaxagoras postulated the cosmos as arising from a rotary motion of Mind, thereby causing a separating effect in the unlimited mass out of which the cosmos finally arises (Curd 2011). The basis for Mind's rule over all things is twofold, namely its ability to cause motion and its omnipresence (McKirahan 1994: 203, 219). In its turn motion causes all changes in the phenomenal world by means of mixture (*synkrisis*) and separation (*diakrisis*). As declared by Anaxagoras, 'The Greeks are wrong to accept coming to be and perishing, for no thing comes to be, nor does it perish, but they are mixed together from things that are and they are separated apart. And so they would be correct to call coming to be being mixed together, and perishing being separated apart' (Fragment 17).

The omnipresence of Mind, or Intellect, implies that it is unlimited (*apeiron*) in time and space. It appears that Anaxagoras refined Anaximander's teaching on the *apeiron* being the *archē* of all things. As commented by McKirahan, 'Mind's unlimited spatial extent, its extreme fineness, and its lack of mixture with other things suggest that Anaxagoras is striving towards the notion of immaterial existence' – an attribute of the Divinity in theistic traditions. In this conception Mind is so fine that it penetrates and permeates other things (i.e. everything outside Mind itself) and causes them to move by its presence (1994: 219-220).

With his doctrine that Mind/Intellect is the ultimate cause of motion, Anaxagoras became the first Western philosopher to clearly distinguish between the mover and the moved. In other words, all the motions of material things can be traced to the action of Mind. Therefore the basis of Mind's rule over all things is its power of causing them to move, not in a random fashion but in a way that sets them in order – the verb *diakosmein* (to set in order) is closely related to the noun *kosmos*, which means order (McKirahan 1994: 220). The phenomenon of motion would be elaborated especially by Aristotle, culminating in his notion of the Prime Mover as the ultimate cause of all motion in the cosmos, and thus the equivalent of Mind.

3.7 Empedocles

The first Western thinker to bring the study of biological phenomena into scientific discourse was Empedocles (around 495-435 B.C.), who hailed from Acragas (later Agrigento) in Sicily. This imposing figure was a combination of poet, orator, scientist, statesman and miracle worker, and even saw himself as a god (Blackburn 2008: 114). In the Hellenic mystical tradition Empedocles is recognised as the poetic, prophetic and theological successor of

Parmenides, ‘the sky-walker whose chariot journey takes him into the House of Night’ (Uzdavinys 2011: 66).

The natural philosophy of Empedocles is presented in his poem *Peri Physeos* (‘About Nature’). Instead of declaring one element to be the *archē* as the Ionians had done, Empedocles postulated four elements which are eternal and ungenerated, namely earth, water, air, and fire (Aristotle *Metaphysics* I.3, 984a). The four elements are also called *rhizōmata* (the plural of *rhizōma*, ‘root’; L&S 625), and all existing things consist of quantitative mixtures thereof. The origin and cessation of things is therefore a process of mixture and separation, which is never-ending (Dreyer 1975: 51). In addition to the elements there are two sources of change: Love (*Philia*) and Strife (*Nikos*), being the causes of the processes of unification and separation (McKirahan 1994: 259).[11] While Love unites and mixes unlike things, Strife sets unlike things in opposition and instead mixes like with like. The ever-changing cosmos is therefore the result of intermediate phases between the extremes produced by the triumph of either Love or Strife (Curd 2011).

Empedocles extended his cosmology to comprise living beings, employing striking imagery to depict the generation of animals. Here are some relevant fragments from his poem:
‘By her [Love] many neckless faces sprouted, and arms were wandering naked, bereft of shoulders, and eyes were roaming alone, in need of foreheads’ (57).
‘In this situation, the members were still single-limbed as the result of the separation caused by Strife, and they wandered about aiming at mixture with one another’ (58).
‘But when divinity was mixed to a greater extent with divinity, and these things began to fall together, however they chanced to meet, and many others besides them arose continuously’ (59).
‘Many came into being with faces and chests on both sides, man-faced ox-progeny, and some to the contrary rose up as ox-headed things with the form of men, compounded partly from men and partly from women, fitted with shadowy parts’ (61).
‘First the whole-natured forms rose up out of the earth, having a portion of both water and heat. These the fire sent up, desiring to come to its like, not yet showing forth at all the lovely shape of its limbs or a voice or the member native to men’ (62).

[11] The Greek *nikē* or *nikos* is also rendered as victory or conquest (L&S 465).

Further light is thrown on Empedocles' bio-philosophy by later commentators. According to Aetius, 'The first generation of animals and plants came to be in no way complete, but split apart with parts not grown together. The second generations arose when the parts grew together, and were like images of fantasy. The third were of whole-natured beings. The fourth no longer arose from the elements, such as earth and water, but from each other from that time, in some because the nourishment grew thick and in others because the beauty of the females caused an excitement of the sexual impulse' (quoted in McKirahan 1994: 278). And Simplicius made the following statement: 'Empedocles says that … next came together these ox-headed man-progeny, i.e. made of an ox and a human. And all the parts that were fitted together in a manner which enabled them to be preserved became animals and remained because they fulfilled each other's needs – the teeth cutting and softening the food, the stomach digesting it, the liver turning it into blood. And when the head of a human came together with a human body, it caused the whole to be preserved, but it does not fit together with the body of an ox, and so it is destroyed. For whatever did not come together according to the appropriate formula perished' (quoted in McKirahan 1994: 278).

In another poem, *Purifications*, Empedocles combines his cosmology with a theological system in which Love is present throughout the universe as the principle of organisation (Blackburn 2008: 114). It appears that for the Sicilian philosopher, Love has a similar cosmic function that the divine Logos has for Heraclitus.

3.8 Diogenes

The last of the Hellenic philosophers of nature (according to the testimony of Theophrastus) was Diogenes of Apollonia, a younger contemporary of Socrates. He drew together various strands from the Presocratic cosmological tradition, thereby playing a notable role as transmitter while also making valuable contributions of his own. The following fragments from Diogenes' writing are relevant to our investigation:

'In my opinion, to sum it all up, all things that are, are differentiated from the same thing and are the same thing … But all these things (earth, water, air, fire, and all the rest of the things in the cosmos), being differentiated out of the same thing, come to be different things at different times and return into the same thing' (2).

'For without intelligence (*noēsis*) it [i.e. the same thing] could not be distributed in such a way as to have the measures of all things – winter and summer, night and day, rains and winds and good weather' (3).

‘Humans and animals live by means of air through breathing. And this (air) is both soul and intelligence for them, as will be displayed manifestly in this book. And if this departs, they die and their intelligence fails’ (4).
‘And in my opinion, that which possesses intelligence is what people call air, and all humans are governed by it and it rules all things. For in my opinion this very thing is god, and it reaches everything and arranges all things and is in everything. And there is no single thing which does not share in this. But no single thing shares in it in the same way as anything else, but there are many forms both of air itself and of intelligence. For it is multiform… And the soul of all animals is the same thing… Now since the differentiation is multiform, also the animals are multiform and many and are like one another in neither shape nor way of life nor intelligence, on account of the large number of their differentiations. Nevertheless, all things live, see, and hear by means of the same thing, and all get the rest of their intelligence from the same thing’ (5).
‘And this very thing is an eternal and immortal body, and by means of it some things come to be and others pass away’ (7).
‘But this seems clear to me, that it is large and strong and eternal and immortal and knowing many things’ (8).

The cosmology of Diogenes is essentially an updated form of Ionian monism (McKirahan 1994: 351). Like Anaximenes, Diogenes postulated air as the basic substance that underlies all things. Like another predecessor, Anaxagoras, he taught that the cosmos is ordered by intelligence, which is called ‘air’ by human beings (Curd 2011). Diogenes evidently views the cosmos as monistic, with all things in it being modifications of the single basic substance, which is symbolised by air. This notion also evokes the eternal *apeiron* of Anaximander, out of which all things arise and to which they return.

Furthermore, for Diogenes the order in the universe is conceived as the result of intelligence, since if everything is arranged in the best possible way, it follows that the cause of that arrangement is intelligent (McKirahan 1994: 346). Plurality and change are not denied by Diogenes, but are viewed as differentiations of the single basic substance, which is both material and intelligent, namely air. Diogenes conceived the cosmos as surrounded by an infinite void, within which an infinite number of worlds (*kosmoi*) come to be and pass away. For the Apollonian thinker the void provides the basis for the differentiation of air, and in this way makes plurality and change possible (McKirahan 347-348, 351). Moreover, Diogenes’ juxtapositioning of intelligence, soul and air evokes the notion by Heraclitus that humans become intelligent by drawing in the *logos* through breathing. We suggest that this correlation also provides an explanation for the Ephesian thinker's omission of air as an *archē* in his cosmology, since air appears to be more closely related to the *logos* than to water or earth.

3.9 Conclusion

The thought of Diogenes represents the terminus of Presocratic cosmology, after which the titanic labours of Plato and Aristotle facilitated advances in the study of nature (McKirahan 1994: 349, 352). The interaction between the various strands in Hellenic cosmology was thus depicted by Proclus: 'This interest in nature is characteristic of the whole Ionian school, as contrasted with the Italian [i.e. Pythagorean and Eleatic]; for the latter was always striving to apprehend the being of intelligibles, in which it saw all other things causally, whereas the Ionian school occupied itself with nature, i.e., with physical actions and effects, and regarded this study as being the whole of philosophy. The Attic school [i.e. Socrates, Plato, and Aristotle], being midway between the two, corrected the Ionian philosophy and developed the views of the Italians' (*Commentary on Parmenides* I.4; Gerson and Dillon 2004: 302).

One should, however, guard against falling into the modern scholarly trap of viewing the Presocratic cosmology as based on naive speculation and therefore inferior to that of their illustrious Athenian successors. As cautioned by Frithjof Schuon, 'One must react against the evolutionist prejudice which makes out that the thought of the Greeks "attained" to a certain level or a certain result, that is to say, that the triad Socrates-Plato-Aristotle represents the summit of an entirely "natural" thought, a summit reached after long periods of effort and groping. The reverse is the truth, in the sense that all the said triad did was to crystallize rather imperfectly a primordial and intrinsically timeless wisdom, actually of Aryan [i.e. Indo-European] origin and typologically close to the Celtic, Germanic, Mazdean and Brahmanic esoterisms' (1984: 63-64). Accordingly, 'With Pythagoras one is still in the Aryan East; with Socrates-Plato one is no longer wholly in the East – in reality neither "Eastern" nor "Western", that distinction having no meaning for an archaic Europe – but neither is one wholly in the West; whereas with Aristotle one begins to become specifically "Western" in the current and cultural sense of the word' (Schuon 1984: 71).

4: Plato

4.1 Introduction

The Hellenic philosopher Plato (429-347 B.C.) was born into a distinguished Athenian family and grew up during the Peloponnesian War between Athens and Sparta. As a youth he became a follower of Socrates, whose death at the behest of the democratic Athenian authorities in 399 B.C. left a lasting impression on the budding philosopher. During the remainder of this decade Plato visited Egypt and possibly Phoenicia, and decided not to pursue a political career (Lee 1987: 11-17). In around 389 B.C. Plato also travelled to southern Italy (then known as Megale Hellas on account of its large Greek population) to study the Pythagorean teachings with Archytas. This philosopher-ruler in all likelihood introduced Plato to the *Quadrivium* of arithmetic, geometry, astronomy and music (Ferguson 2011: 120, 137). Shortly after his return to Athens, Plato founded the Academy in 387 or 386 B.C. This venerable institution would continue its work in various guises for over 900 years until its effective closure by the Roman Emperor Justinian in 529.[12] The Athenian Academy became the forerunner of the medieval European universities, for which Plato therefore deserves credit as prime mover.

In addition to the Pythagorean philosophy, the Orphic tradition (*Orpheos paradosis*) contributed much to the formation of Plato's spiritual-intellectual world. The Neoplatonists viewed the philosophy of Plato as an extension of the Orphic theology, with Olympiodorus asserting that Plato paraphrases Orpheus everywhere (Uzdavinys 2004: xvii-xviii). Moreover, the Platonists believed in a primordial revelation given to the ancient sages and theologians, which explains why there cannot be any novelty in the expression of metaphysical truth. It was affirmed by Celsus that Plato never claimed to have taught anything new – a stance that Plotinus would also assume. Nonetheless, this conviction does not preclude the casting of metaphysical truth into new styles, as explained by Algis Uzdavinys: 'changing historical conditions, the personal characteristics of philosophers and their audiences, as well as concrete philosophical problems to be solved, inevitably determined certain logical forms and the style of any particular philosophical discourse' (2004: xviii).

[12] The adjective 'Byzantine' that is often applied to the Eastern Roman Empire is a creation of modern Western historians, contrived to present the Germanic ('Holy Roman') Empire founded by Charlemagne in 800 as the legitimate successor to the Western Roman Empire. In reality, the so-called 'Byzantine' Empire was the *de jure* continuation of the old Roman Empire, so that the 'Byzantine' Emperors were only ever known as Roman Emperors, until the fall of Constantinople in 1453. The Eastern Roman Empire thus outlived the fall of its Western counterpart by almost a millennium.

Plato is credited with having written thirty-five dialogues, which were edited in the first century A.D. by Thrasyllus of Alexandria. This Platonist philosopher added a set of thirteen *Letters* (of which some are of doubtful authenticity) to Plato's dialogues, with the whole corpus divided into nine tetralogies, or groups of four works each. Plato did not write any philosophical treatises as such, probably due to his conviction that human language is too defective to fully express truth (Cooper 1997: viii-ix; 1635). Nevertheless, Plato believed that with strenuous intellectual effort it is possible to move away from error and towards truth: 'Only when all of these things – names, definitions, and visual and other perceptions – have been rubbed against one another and tested, pupil and teacher asking and answering questions in good will and without envy – only then, when reason (*dianoia*) and knowledge (*epistēmē*) are at the very extremity of human effort, can they illuminate the nature of any object' (*Letter VII*). Various levels of truth (*alētheia*) are distinguished by Plato, following the traditional view of truth as multifarious. Thus the highest truth is the light proceeding from the Good; second is the intelligible truth that illuminates the intellectual orders; third is the psychical truth found in souls, which through intelligence comes into contact with true being; and lowest is the truth obtained through the senses, which is full of error due to the instability of its object, because material natures are perpetually flowing (Taylor 2010: 110).

In his late dialogue *Timaeus* the Athenian philosopher presented a cosmology that would achieve lasting significance in Western philosophy and theology. Together with its immediate successor, the *Critias*, the *Timaeus* is Plato's penultimate work, with only the *Laws* being certainly later. These works comprise a trilogy that entails a continuous account of the world from its creation through prehistoric legend and all historic time up to Plato's project for future socio-political reform (Cornford 1997: 1, 8). The narrative of the *Timaeus* moves from the ideal world of the Demiurge and the eternal Forms to the visible universe and the nature of humankind. Interestingly, the parallel of macrocosm and microcosm runs through the whole dialogue, notably as it pertains to the World-soul and the human soul (Cornford 1997: 6). That is to say, for Plato the macrocosm is the ontological point of reference for the numerous microcosms. In terms thereof the macro-cosmic unity is the ground from which all things arise and to which all things return (Goosen 2007: 163).

According to the Neoplatonist philosopher Iamblichus, the whole of Plato's thought is contained in the *Timaeus* and the *Parmenides*, dealing with the structure of the sensible and intelligible worlds, respectively (Dillon and Gerson 2004: xv). Interestingly, in these two works Socrates plays a subordinate role as learner, being instructed by Parmenides and Timaeus in theological dogmas and cosmology, respectively (Taylor 2010: 88). Another Neoplatonist, Proclus, declared in his *Commentary on Timaeus* that the subject of the dialogue is the totality of the science of nature. It is therefore a study of the universe, which it treats of from its beginning to its end. Proclus affirmed that Plato preserved the Pythagorean approach to the study of nature – a view that was reinforced by the Neo-Pythagorean work of the same title (i.e. *Timaeus*) and subtitled 'On the Nature of the Soul and the World' (Dillon and Gerson 2004: 331). Elsewhere Plato provided an explanation of natural science as dealing with "the causes of everything, why it comes to be, why it perishes and why it exists" (*Phaedo* 96a). In other words, the domain of natural science is causality, generation, cessation, and substance.

A tripartite composition of the dialogue has been proposed by Proclus. In terms thereof, the prologue (17a-27d) provides a view of the universe through the medium of images – namely, an ideal state and the Atlantis-Athens conflict. The middle section (27d-76e) entails an account of the whole composition of the universe, while postulating creative, paradigmatic, and final causes. The final section (76e-92c) deals with particular beings and the final details of creation, interwoven with general principles (Dillon and Gerson 2004: 334-335). A variant yet equally convincing division has been suggested by Francis Cornford. In the 'works of Intellect' (29d-47e) Plato approaches the world as it were from above, dealing with the creation of the world's soul and body, the heavenly gods, and the human soul, sight and hearing; in 'what comes about of necessity' (47e-69a) the philosopher approaches the world as it were from below, where the Demiurge imposes rationality onto chaos by means of geometric figures; and in the third section (69a-92c) Plato weaves together rational purpose and necessity, while dealing with the human body, organs and disorders (Cornford 1997: 32-33). In other words, the discourse unfolds in three stages, depicting successively the achievements of Intellect, the effects of Necessity, and the co-operation of Intellect and Necessity in the psychophysical constitution of human beings (Zeyl 2009). The last two of Cornford's sections have been combined by Gregory Vlastos as depicting the compromises of teleology with necessity, while the first section portrays the triumphs of pure teleology. In terms of movement, the first division (29e-47e) deals mainly with the teleologically ordered motions of souls, while the second division (47e-69b) deals with the mechanistically ordered motions of earth, water, air, and fire (Vlastos 1975: 28, 66). The Athenian philosopher thus interweaves the realms of teleology and mechanism into a coherent cosmological whole.

The prologue of the *Timaeus* consists of two parts: first, Plato's mentor Socrates recapitulates the previous day's discussion of an ideal state, and then Critias sketches the existence and fall of Atlantis. According to Proclus, the account of an ideal state is an image of unity, while the tale of Atlantis is an image of division, or to be more precise, opposition into two classes of things. The eminent Neoplatonist thinker also likens the two parts of the prologue to the order of the heavens and the realm of generation, 'which is based on conditions of opposition and change', respectively (Dillon and Gerson 2004: 334-335). Contrary to the modern scholarly view that Plato's account of Atlantis is purely mythical, Iamblichus insisted that the conflict between Athens and Atlantis refers to both historical events ('since it is generally agreed that they took place')[13] and as extending throughout the whole universe: 'For since all things derive both from the One and from the Dyad after the One [i.e. Limit and Unlimitedness] and are united in a way with each other and have been allotted an antithetical nature – even as among the classes of Being there is a certain antithesis of the Same against the Different, and of Motion as opposed to Rest, and all things in the universe partake of these classes – so it would be a good idea to view the conflict as extending through all these levels of existence' (*Commentary on Timaeus*; quoted in Dillon and Gerson 2004: 250). This notion of cosmic conflict between pairs of opposites evokes Heraclitus and Pythagoras.

An associate of Socrates, Timaeus (introduced as an expert in astronomy), is then invited by Critias to share his knowledge concerning the nature of the universe, 'beginning with the origin of the universe, and concluding with the nature of human beings' (27a). Unlike the bulk of Plato's dialogues, the remainder of the *Timaeus* assumes the nature of a monologue (except for a brief interjection by Socrates at 29d). This provides the Athenian philosopher with a literary framework within which to elucidate his mature cosmological thought in the manner of a reasoned exposition, rather than by way of a Socratic dialectic (Zeyl 2009). The result of this Platonic project is philosophy as 'grandiose and rhetorically elaborate cosmic theorizing'

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[13] The Neoplatonic conviction that Plato's account of Atlantis is not only mythical or symbolical received tentative confirmation in the twentieth century from the science of marine archaeology. Various underwater structures of walls, buildings, a pyramid, a circle of pillars and a stone causeway have been discovered off the Bahaman islands, notably Bimini. Their geographical location accords with the statement in the *Timaeus* that Atlantis was situated some distance beyond (i.e. to the west of) the Straits of Gibraltar. It is also pertinent that the submerged walls off Bimini were built with cyclopean stones, similar to those used in the Mediterranean world during the Bronze Age (and which this author has observed at Mycenae in Greece). In his valuable works *The God-Kings and the Titans* (1973) and *Sailing to Paradise* (1994), James Bailey presents an array of archaeological evidence indicating maritime trade between the Americas, Africa, Europe and Asia during the Bronze Age.

(Cooper 1997: 1224).

We will investigate relevant themes of the *Timaeus* by means of the following structure (with quotes obtained from Donald Zeyl's translation, except where otherwise indicated):
(a) The fundamental differentiation between being and becoming;
(b) The role of Intellect as thesis;
(c) The receptacle of becoming as mediator between being and becoming;
(d) The role of Necessity as antithesis; and
(e) The co-operation of Intellect and Necessity as synthesis.

4.2 Fundamentals: being and becoming

Plato introduces his account in the *Timaeus* with an ontological differentiation: 'As I see it, then, we must begin by making the following distinction: What is that which always is and has no becoming, and what is that which always becomes but never is? The former is grasped by understanding (*noēsis*), which involves a reasoned account (*logos*). It is unchanging. The latter is grasped by opinion (*doxa*), which involves unreasoning sense perception (*aisthēsis alogos*). It comes to be and passes away, but never really is' (27d-28a). These realms of unchanging being and ever-changing becoming are referred to as the intelligible world and the sensible world. In this way Plato affirms the realm of becoming, as did Heraclitus, as well as the realm of being, as did Parmenides (Dreyer 1975: 94). For Plato the intelligible (*to noēton*) entails all that has its essence separate from sensible objects. It signifies the various levels of (i) the first principle (*hyparxis*), (ii) true being, (iii) intellect, and (iv) soul (Taylor 2010: 108).

In a seminal departure from some of his predecessors, Plato affirms that the world order (*kosmos*) does not exist in eternity, but has an origin and therefore came to be. The world is visible and tangible, and as such is grasped by sense perception and opinion (28b-c). Since the universe is perceptible, we cannot have true knowledge (*epistēmē*) of it, but only opinion (*doxa*) or belief (*pistis*). Plato therefore admits that the dialogue is a 'likely account' (*eikos logos*; 29d). As Proclus argued, the faculty of sense-perception is unreasoning in several ways, for example the sun looks small from the earth; therefore the truth can only be apprehended by the higher faculty of understanding. Since the visible world is only a likeness of the intelligible world, any account of it can be no more than a likely one (Cornford 1997: 24, 28). Consequently, for Plato there can be no exact science of natural things, since they are always changing. In this context the term 'likely' (*eikos*) means probable or plausible, and thus the cosmology of the *Timeaus* is poetry that approximates the truth rather than a literal statement of physical laws (Cornford 1997: 30). It is therefore legitimate to view the *Timaeus* as a mytho-poetical account of the cosmos and its origins, and not a literal depiction.

For Plato the sensible world is the equivalent of Heraclitus' world of ceaseless becoming. As stated by Socrates in the dialogue *Theaetetus*, 'What is really true, is this: the things of which we naturally say that they "are", are in process of coming to be, as the result of movement and change and blending with one another. We are wrong when we say they "are", since nothing ever is, but everything is coming to be' (152d-e). Nevertheless, this ever-changing realm is not unreal or illusory, but real insofar as it partakes of the intelligible world of Ideas (or Forms). The 'otherworldliness' that Plato's philosophy has often been labelled with is at most of a peculiar and particular kind, as remarked by Arthur Lovejoy. As a matter of fact, 'The sensible world was never for Plato a mere illusion or a mere evil. And the other [i.e. intelligible] world, as well as this, was a plurality; and there was also a plurality of individual souls, permanently separate from one another and distinct from the Ideas, even when translated into that higher region' (Lovejoy 1960: 38). That is to say, there is no question of either a metaphysical monism or dualism in Plato's thought, but rather a differentiated unity.

The notion of Forms, or Ideas, is defined by Socrates in the *Parmenides*: 'These forms are like patterns set in nature, and other things resemble them and are likenesses; and this partaking of the forms is, for the other things, simply being modeled on them' (132d). Viewed in terms of traditional Indo-European metaphysics, it therefore follows that all the conditions of sensible existence are rooted in universal principles. Thus matter refers to the divine Substance, or *Prakriti*; form reflects the divine Logos, or *Purusha*; number refers to the divine Unity; space is the expanse of divine Manifestation; and time is the rhythm of cosmic cycles, the 'days and nights of *Brahma*' (Schuon 1982: 65-66). The most fundamental properties of the Forms are eternity and immutability, which they acquire through participation in the Good (Lovejoy 1960: 40-41). Moreover, for Plato the Forms are the only real being outside time and space; in other words, the Forms are the limited (*peras*). The opposite thereof is the unlimited (*apeiron*), in other words non-being, which is empty space (*to kenon*). Empty space is the negation of being and therefore exists only as a possibility (Dreyer 1975: 100).

In Plato's cosmology the world of sensible phenomena is interposed between the extremes of that which is (*to on*) and that which is not (*to mē on*) – that is to say, between true being and non-being. As stated in the dialogue *Republic* (its title *Politeia* could also be rendered State, Statesman or Commonwealth: L&S 571), the sensible realm participates (*metechein*, to partake of) in both being and non-being. It is therefore the realm of opinion, which lies between knowledge, related to what *is*, and ignorance, related to what *is not* (Book V, 478d-e). The sensible world is thus conceived as simultaneously real, on account of participating in the Forms, and unreal, on account of existing in non-being (Dreyer 1975: 100). In this way Plato establishes an ontological hierarchy of firstly the intelligible world (true being), then the sensible world (relative being), and finally the abstract realm of non-being.

It is important to note that Plato's distinction between sensible and intelligible worlds does not imply a metaphysical dualism, since the sensible world is not deprived of intelligibility (Dillon and Gerson 2004: xx). This was affirmed by Thomas Aquinas, who remarked that Plato's notion of participation in immaterial forms provide existence and intelligibility to the world. Both bodily matter and mind are formed through participation in these ideas: 'matter being formed into particular things having their own specific and generic natures, and mind into knowing such species and genera' (*Summa Theologiae* 1a79; McDermott 1993: 148). While the intelligible world is unextended in space and time, the sensible world is extended in space and time as a reflection or copy of the former. These realms are correlative, since the unity of the intelligible world is in every way compatible with the multiformity of its manifestations in the sensible world (Coomaraswamy 1989: 72).

For Plato the soul is the link between the eternal realm of being and the ever-changing world of becoming: through rational thought it perceives being and through sense-perception it observes becoming (Vlastos 1975: 31). The reality of soul thus affirms the reality of both being and becoming, while also preventing a dichotomy between the intelligible and sensible realms. Thus Plato argued that the true philosopher will reject both of the notions that everything is at rest or that reality changes in every way. Instead, 'He has to be like a child begging for "both", and say that *that which is* – everything – is both the unchanging and that which changes' (*Sophist* 249c-d).

The relation of the intelligible Forms toward sensible things was naturally explored by Plato. In earlier dialogues he suggested that objects participate in the Forms or that they mimic the Forms. Among the Forms the highest is the Form of the Good (*idea tou agathou*), which was introduced in the *Republic*. For Socrates the term 'good' held the connotations of selfsufficiency (*autarkeia*) and perfection (*teleioteta*), as argued in the dialogue *Philebus* (60c; Oosthuizen 1974: 46-47). In the *Republic* this conception is expanded by Plato, so that the Form of the Good is also the highest and most perfect Being, which would in due course become the One of the Neoplatonists and the *ens perfectissimum* of the medieval Schoolmen. Since the Good is the ultimate reality, it is an indescribable beauty before which ordinary speech falters. It is also the universal object of desire, drawing in all souls capable of contemplation the Good (Lovejoy 1960: 39-42). In other words, the Form of the Good is none other than the Absolute, or God.

In Book VI of the *Republic*, the Analogy of the Sun is employed to illustrate the Form of the Good, while simultaneously touching upon the participation of the many in the one. To begin with, Socrates makes a distinction between sets of particular things that exist, for example things of beauty or of goodness, and a single, unique form for each set, such as beauty-in-itself and goodness-in-itself (507b). Referring to the Sun, Socrates then argues that ‘The good has begotten it in its own likeness, and it bears the same relation to sight and visible objects in the visible realm that the good bears to intelligence and intelligible objects in the intelligible realm’ (*Republic* 508b-c; Lee’s translation). This analogy has been summarised as follows by Desmond Lee: Just as in the visible world the Sun is the source of growth and light, which gives visibility to objects of sense and the power of seeing to the eye, so in the intelligible world the Good is the source of reality and truth, which gives intelligibility to objects of thought and the power of knowing to the mind (Lee 1987: 306).

One of the eminent Greek Patristic theologians, Dionysius the Areopagite, drew the Platonic cosmology (particularly that of Proclus) into Christian theology. Following Plato, Dionysius illustrated the activity of the Good by means of analogy with the Sun, which illuminates and nourishes the things we perceive, establishes the differences between them and unifies them, and quickens and gives life to them. But the Sun is itself created by the Good, and therefore ‘All this holds all the more truly with respect to the Cause which produced the sun and which produced everything else. The exemplars of everything preexist as a transcendent unity within It. It brings forth being as a tide of being’ (*Divine Names*, 5.8).

Plato reasons that the Form of the Good serves not only as the ground of our knowledge concerning the sensible world, but also of the latter’s reality as such: ‘The good therefore may be said to be the source not only of the intelligibility of the objects of knowledge, but also of their being and reality; yet it is not itself that reality, but is beyond it, and superior to it in dignity and power' (*Republic* 509b; Lee's translation). With the Analogy of the Sun the Athenian thinker elegantly addresses an objection to his theory of Forms raised in the *Parmenides* (131a-e), namely how a single Form can be participated in by many particulars without itself becoming many. The solution is that the light produced by the sun is divisible, but the source of the light is not; thus the relationship of Form to particular is like the relationship of the sun to the places it lights up (Simpson n.d: 5-7).

Another objection to Plato's theory of Forms that was raised in the *Parmenides* pertains to the likeness between Forms and particular objects. While Socrates declared that objects participate in the Forms by being made like them as copies based on their models, Parmenides countered that for an object to be like a Form and vice versa, there has to be an additional Form in which both the object and the original Form can participate, and so on *ad infinitum* (132a-b). This criticism is known as the likeness regress and formed the basis of Aristotle's Third Man argument against Plato's theory of Forms. However, in Book V of the *Republic* a comparison is made by Socrates between a dreaming man who confuses a resemblance and the reality which it resembles on the one hand, and an awake man who can see both beauty itself and the particular things which participate (*metechein*) in it on the other hand (at 476c-d). This distinction between sameness and likeness rebuts Parmenides' objection, since the Form is the same as itself while the particulars are like it, so that there is no need for a further Form of likeness to explain the likeness of the Form to the particulars (Simpson n.d.: 7-9).

It should be noted that Aristotle himself credits the Platonists for introducing the Third Man argument against an inadequate understanding of Forms (*Metaphysics* Book XIII, 1079a). Therefore, Lloyd Gerson remarks, Aristotle had to be aware that in the Academy arguments such as the Third Man were employed to distinguish between inadequate and adequate understandings of the Forms (2005: 228). In his *Commentary on Aristotle's Metaphysics*, the Neoplatonist Asclepius presented convincing arguments against the Third Man argument. In the first place, the argument is only valid if Forms are conceived as existing separately from the divine Intellect. Secondly, since Forms do not exist separately from the Intellect, they are not to be identified with sensibles. Therefore, Asclepius concludes, a Form and the sensibles partaking in it do not require another Form over and above it (Gerson 2005: 228).

Plato further explored the relation between the one and the many by means of the Pythagorean notion of the unlimited or indefinite (*to apeiron*) and the limiting or definite (*to peras*). Thus in the dialogue *Philebus* we find Socrates acknowledging as a gift from the gods to men, 'that whatever is said to be consists of one and many, having in its nature limit and unlimitedness' (16d). This implies that every plurality lies between the unlimited and the one. Furthermore, everything that exists in the universe can be divided into four metaphysical categories: the unlimited, the limit, the mixture of these two, and the cause of the mixture (*Philebus* 16e, 23c-d). However, Plato modifies the Pythagorean terminology into the One (signifying unity) and the Indefinite Dyad (signifying plurality).[14] The notion of the Indefinite Dyad implies the possibility of numbers and of opposites, since neither could exist if all things were one. According to this cosmogony, initially the One acts upon the Indefinite Dyad and produces the definite number of two. In the same way all the numbers up to ten are generated, from which point numbers are organised into geometry. Plato also continues the Pythagorean progression of point → line → surface → solid, so that the entire cosmos arises out of the interaction between the One and the Indefinite Dyad (Ferguson 2011:135-136).

Finally, in the *Timaeus* the Forms serve as models or patterns (*paradeigmata*) on which the Maker of the cosmos based all things (Dreyer 1975: 94). Here Plato expands his notion of participation of the many in the one by postulating a third kind of entity, situated between the Forms and sensible things. Moreover, the Athenian philosopher introduces for the first time in Hellenic philosophy a comprehensive scheme of creation by a divine Craftsman, so that the world resembles a work of art that is designed with a purpose (Cornford 1997: 31). This world-maker is referred to by Plato as the Father, or more often the Demiurge (*ho Demiourgos*). In this way the notion of self-sufficing perfection (i.e. the Good of the *Republic*) was converted into the concept of self-transcending fecundity, as remarked by Arthur Lovejoy. He adds, 'A timeless and incorporeal One became the logical ground as well as the dynamic source of the existence of a temporal and material and extremely multiple and variegated universe. The proposition that … *omne bonum est diffusivum sui* [Latin, the Good is self-diffusing] here makes its appearance as an axiom of metaphysics' (1960: 49).

Since Plato insists that the participation of immanent things in the transcendent reality of the Forms is what constitutes cosmic reality, it is erroneous to accuse the Athenian thinker of emphasising transcendence at the cost of immanence. Contrary to this charge by Nietzsche,

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[14] The Indefinite Dyad should not be confused with the number 2, which as the definite dyad is the smallest number for both Plato and Aristotle (Gerson 2005: 234).

inter alia, the Platonic notion of participation entails 'a shining affirmation of immanence', as stated by Danie Goosen (2007: 200). Through their participation in the transcendent reality, the immanent things obtain a weight and durability which would have been impossible without such participation. Thus, 'In and through their participation in the transcendent, the immanent things itself become a glowing reality.' The South African philosopher adds that the rejection of immanence cannot be attributed to Platonism, but rather to the Gnostic deviations from it and the modernist continuation of these deviations (Goosen 2007: 200-201). Thus, following the Nietzschean condemnation of metaphysical dualism, Heidegger rejected the Platonic theory of participation, since the latter is said to presuppose a dualism of beings and Being. However, the metaphysical tradition does not proclaim an ontological chasm between beings and Being, but rather affirms that the world exists due to both the distinction and the coherence between Being and beings (Goosen 2007: 33, 340-341).

For Plato the ontological reality of the Forms harbours momentous epistemological consequences. In the *Parmenides* we find the protagonist arguing that if the existence of the Forms is denied on account of the objections raised, then the power of dialectic (or discourse, *dialegesthai*) will be destroyed entirely (135b-c). That is to say, meaningful discourse will become impossible without the presence of Forms to ensure the intelligibility of the objects of discourse. Lloyd Gerson explains: 'This intelligibility consists in the samenesses and differences in the sensible world which are ultimately explained by Forms' (2005: 211). In addition, the reality of the Forms and the physical things that participate in them entails a hierarchy of mental states, as illustrated by means of the Analogy of the Divided Line in Book VI of the *Republic* (509d-511e). The subdivisions of the line are (i) intelligence (*noēsis*) and (ii) reasoning (*dianoia*), which both perceive the intelligible realm (*to noēton*), and (iii) belief (*pistis*) and (iv) illusion (*eikasia*), which both perceive the visible realm (*to horaton*). Intelligence, or the science of dialectic, leads to a direct vision of ultimate truth; reasoning is deductive and pertains especially to mathematics; beliefs ('common sense') are helpful in everyday life but cannot by itself lead to truth; and the illusions filling the unreflecting minds of the many perceive only the shadows and images of things (Lee 1987: 310-311). Or as affirmed in the *Timaeus*, natural science cannot lead to true knowledge, since it deals with mutable, physical objects and not with the immutable Forms.

The presence of the Good in the intelligible and sensible worlds not only holds ontological and epistemological implications, but also relates to morality and aesthetics. In the celebrated

Analogy of the Cave (in Book VI of the *Republic*), Socrates explains the matter as follows to Glaucon: ‘In the knowable realm, the form of the good is the last thing to be seen, and it is reached only with difficulty. Once one has seen it, however, one must conclude that it is the cause (*aitia*) of all that is correct (*orthos*) and beautiful (*kalos*) in anything, that it produces both light (*phos*) and its source in the visible realm, and that in the intelligible realm it controls and provides truth (*alētheia*) and understanding (*nous*), so that anyone who is to act sensibly in private or public must see it’ (517b-c). In summary, for Plato the Form of the Good is the ground of all that exists (Oosthuizen 1974: 47).

4.3 Thesis: the role of Intellect

Whereas some of the Presocratic viewed the cosmos as uncreated, Plato ascribes the origin of the world to the creative activity of a transcendent being which acts upon nature without being acted upon (Vlastos 1975: 25). In the *Timaeus* the role of the divine Craftsman, or Demiurge, is introduced as follows: ‘Now everything that comes to be must of necessity come to be by the agency of some cause, for it is impossible for anything to come to be without a cause. So whenever the craftsman looks at what is always changeless and, using a thing of that kind as his model, reproduces its form and character, then, of necessity, all that he so completes is beautiful. But were he to look at a thing that has come to be and use as his model something that has been begotten, his work will lack beauty’ (28a-b). In keeping with his mystical approach to reality, Plato assumes an apophatic stance with regards to the Creator: ‘Now to find the maker and father of this universe (*to pan*, literally ‘the all’) is hard enough, and even if I succeeded, to declare him to everyone is impossible’ (28c). The Demiurge uses the eternal model of being to make the universe, and therefore the universe is beautiful and excellent: ‘it is a work of craft, modelled after that which is changeless and is grasped by a rational account, that is, by wisdom’ (29a). That is to say, the realm of becoming is modelled upon the realm of being by the divine Craftsman.

According to Plato, goodness is an essential attribute of the divinity. Thus in Book II of the *Republic*, dealing with the education of the Guardians, we find Socrates declaring that God is the sole cause of good (*agathos*) and not in any way the cause of evil (*kakos*). In addition, since God is perfect in beauty and goodness, he is eternally without change or variation (379c, 381c). In the *Timaeus*, the goodness of the Demiurge is stated as the motive for creation: ‘He was good, and one who is good can never become jealous of anything. And so, being free of jealousy, he wanted everything to become as much like himself as was possible… The god wanted everything to be good and nothing to be bad so far as that was possible, and so he took over all that was visible – not at rest but in discordant and disorderly motion – and brought it from a state of disorder to one of order, because he believed that order was in every way better than disorder... Accordingly, the god reasoned and concluded that in the realm of things naturally visible no unintelligent thing could as a whole be better than anything which does possess intelligence as a whole, and he further concluded that it is impossible for anything to come to possess intelligence apart from soul. Guided by this reasoning, he put intelligence in soul, and soul in body, and so he constructed the universe... This, then, in keeping with our likely account, is how we must say divine providence brought our world into being as a truly living thing (*zoion*), endowed with soul and intelligence' (29e-30c). In this way, Proclus comments, the world is portrayed as dependent on the universal demiurgic Intellect, created in the likeness of the intelligible living being, and viewed as good by reason of its participation in the Good (Dillon and Gerson 2004: 334). Plato's depiction of the Demiurge as devoid of jealousy represents a striking contrast with the Judaic conception of a jealous divinity, as declared in the Hebrew scriptures (see for example Exodus 20:5 and Deuteronomy 5:9).

Some recent commentators have suggested that Plato's Demiurge should not be conceived as a divine Intellect or a personal ruler, but rather as a manual labourer (Cohen 2006). Similarly in the words of Hierotheos Vlastos (1975: 26), 'That the supreme god of Plato's cosmos should wear the mask of a manual worker is a triumph of the philosophical imagination over ingrained social prejudice.' However, the Greek scholar concedes that the Demiurge is primarily an artist: 'He is an artist or, more precisely, what an artist would have to be in Plato's conception of art: not the inventor of new form, but the imposer of pre-existing form on as yet formless material' (Vlastos 1975: 27). With the latter sentence an accurate interpretation is provided, since the Demiurge indeed impresses the eternal Forms onto formless matter by means of a mediating receptacle, thus creating the cosmos out of chaos.

Contrary to any reductionist conception, the Neoplatonist thinkers unequivocally affirmed the divinity of Plato's Demiurge. Plotinus equates the Demiurge with Intellect (*Enneads* V, 1, 2), which is the second hypostasis of the Divinity. Later Proclus declares, 'The highest god is the Good, and after him and second there is the Demiurge, and third is the Soul of the Universe; for the divine realm proceeds as far as Soul' (quoted in Dillon and Gerson 2004: 203). This metaphysical notion of three Divine hypostases also rebuts the assertion by Petrus Dreyer (1975: 101) that the concept of the Demiurge was obtained by Plato from popular religion.

Plato's Demiurge could also be viewed as comparable to the Egyptian god Ptah, the divine intermediary between the creative idea and the physical product, and to Jesus Christ as the *Logos* through whom all things are created in the Christian tradition (Ferguson 2011: 130).

However, in the Neoplatonic understanding the Demiurge is not viewed as a personal deity in the Biblical sense (Gerson 2005: 129). It would also be erroneous to ascribe omnipotence to Plato's Demiurge in an attempt to make the latter conform to the Christian Creator-God, who creates 'out of nothing' (*ex ouk onton*). The concept of an omnipotent Creator is in fact foreign to Hellenic thought, which rejects the possibility of creating something out of nothing. Thus the eminent physician Galen contrasted the doctrine of Moses on divine omnipotence with that of Plato and other Greeks who 'studied nature correctly' (Cornford 1997: 36). Therefore, 'Plato's Demiurge… is represented as like the human craftsman, who must have materials to work with. His task is to bring some intelligible order into a disorder which he 'takes over', not to create the material before he fashions it' (Cornford 1997: 165). Plato also reiterates throughout the *Timaeus* that the benevolent Demiurge designs arrangements to be 'as good as possible.' The Demiurge is not the sole cause of becoming, since there are secondary causes, and moreover he did not create the receptacle of becoming or the Forms. Finally, the function of the Demiurge is to contribute an element of order to the realm of becoming, because an ordered world will be more like himself (Cornford 1997: 36-37).

It has already been mentioned that the Demiurge creates the world according to the model of eternal being. To be more precise, Plato reasons that the visible world is modelled on an intelligible Living Thing: 'Rather, let us lay it down that the universe resembles more closely than anything else that Living Thing of which all other living things are parts, both individually and by kinds. For that Living Thing comprehends within itself all intelligible living things, just as our world is made up of us and all the other visible creatures. Since the god wanted nothing more than to make the world like the best of the intelligible things, complete in every way, he made it a single visible living thing, which contains within itself all the living things whose nature it is to share its kind' (30c-31a). In other words, this intelligible Living Thing is the generic Form that contains within itself the Forms of all subordinate species of which the members inhabit the visible world. Since its eternal being is in the realm of Forms, the Living Thing is not itself a living creature (Cornford 1997: 40). It was emphasised in this regard by Donald Zeyl (2009) that the Demiurge does not make the world by simply copying the Living Thing; rather, he is challenged to craft an image that is subject to the constraints of becoming.

Since there is only one intelligible Living Thing, there is only one visible universe which is crafted after its model (31a-b). Plato adds that the Demiurge made the tangible, visible world from the four elements of fire, air, water, and earth, with the whole bound together as a symphony of proportion (32b-c). As a result, 'They [the elements] bestowed friendship (*philia*) upon it, so that, having come together in a unity with itself, it could not be undone by anyone but the one who had bound it together [the Demiurge]' (32c). In addition, the body of the world was fashioned in such a manner as to be free of old age and disease (33a).

Plato continues that the world was created spherical in shape: 'He [the Demiurge] gave it a shape appropriate to the kind of thing it was. The appropriate shape for the living being that is to contain within itself all the living beings would be the one which embraces within itself all the shapes there are. Hence he gave it a round shape, the form of a sphere, with its centre equidistant from the extremes in all directions… This of all shapes is the most complete and like itself, which he gave to it because he believed that likeness is incalculably more excellent than unlikeness' (33b). As a matter of fact, the sphere is the most uniform of all solid figures and the only one which can move without change of place, through rotating on its axis. For Plato the rotation of the world with all its contents shows the penetration and rule of intelligence over the entire universe (Cornford 1997: 54, 57). Of further astronomical interest is the dialogue *Epinomis* (probably written by an early follower of Plato), which declares that the Sun is larger than the Earth and that all the moving stars have an immense size. Moreover, God is the cause of their constitution and their movement (*Epinomis* 983a).

What happens next in the creative process is of the utmost significance for Plato's cosmology. The Demiurge sets soul (*psychē*) in the centre of the cosmos, so that the soul is given priority to rule over the physical universe (34b-c): 'And he [the Demiurge] placed soul into the midst of it, and stretched it through the whole of it, and enveloped its body with it from without' (34b). According to Porphyry and Iamblichus the term 'the midst' is not to be understood in a spatial and dimensional sense, thus confining the soul of the universe to some part of it, but rather as referring to soul being present everywhere equally and leading all things by its own motions (Dillon and Gerson 2004: 251). The visible world is therefore a living creature, having soul (*psychē*) in its body and mind (*nous*) in its soul. It is called a god (34b) in the same sense as the stars, planets, and Earth, which are heavenly gods (Cornford 1997: 38).

Since for Plato soul is the only entity capable of self-motion, all the celestial motions have to be explained as psychokinesis (Vlastos 1975: 31).

In its turn this World-soul is the bearer of the reason (*logos*), which works in on the whole cosmos. Therefore, Dreyer (1975: 101) comments, the cosmos is ordered and lawful. For Plato the World-soul precedes the existence of the corporeal world. Material things can only move if they are moved by an external agency, but in the Platonic conception soul possesses inherent movement and is thus the cause of all movement. The World-soul is intermediate between Ideas and matter, and is thus the force through which matter participates in the Ideas. Since soul is identical with life (*psychē* is translated as breath, life or soul: L&S 798), the cosmos is a living being (Dreyer 1975: 101). Furthermore, as Plato reasoned in the *Laws*, soul is not only the source of motion, but is more specifically the first cause of the birth and destruction of all physical things (891e), the main cause of their alterations and transformations (892a), and the cause of all change in things (896a). Evidently, Plato's conception of the cosmos is thoroughly psycho-physical and not materialistic.

Plato describes the soul as a mixture of Being (or Existence), the Same (*tauton*), and the Different (*heteron*) (35a-b). According to Plotinus, this notion of Plato indicates the construction of the soul of the universe from the Same and the Different (*Enneads* VI, 7, 13; Dillon and Gerson 2004: 140). The terms for the three components of soul is explained by Plato in the dialogue *Sophist*: every Form exists, is the same as itself, and is different from every other Form. The Athenian thinker conceives of the World-soul and all individual souls as partaking of both being and becoming, since soul is like the Forms due to being immortal and incomposite, but unlike the Forms in that it is alive and intelligent, and life and intelligence cannot exist without change (Cornford 1997: 61-64).

The further construction of the World-soul is depicted by Plato in terms of Pythagorean numerology. First the Demiurge took a portion away from the whole of the above-mentioned mixture, then he took another portion twice as large, then a third three times as large as the first, followed by a fourth portion twice as large as the second, a fifth three times as large as the third, a sixth eight times that of the first, and finally a seventh portion twenty-seven times that of the first (35b). The sequence of these portions of the World-soul are 1, 2, 3, 4, 9, 8 and 27. The first four of these numbers represent the *tetractys*, while 9 is the square of 3, and 8 and 27 are the cubes of 2 and 3 respectively. Plato stopped the sequence with cubes because only three dimensions are required in the creation of physical reality (Ferguson 2011: 130-131). Through these connected geometrical proportions Plato establishes in the soul the source of the harmonious order it has to impart to the three-dimensional body of the cosmos (Zeyl 1997: 1239). The soul is invisible, Plato continues, and is the most excellent of all things begotten by the Demiurge (36e-37a).

It is interesting to note that Plato also has the Demiurge slice the World-soul into two halves, joined at the centre to form an X at one point and bent back to form two circles, called the Same and the Different (36b-d). In astronomy two such rings are known to exist, namely the celestial equator and the ecliptic. While the celestial equator anchors the sphere of the fixed stars and thus stays the same, the ecliptic changes according to the cycles of the Sun and the planetary orbits. Moreover, by asserting that these rings move in opposite directions, Plato (and his Pythagorean predecessors) correctly explained the motion of celestial bodies as a combination of opposite movements (Ferguson 2011: 131-133).

Together with the cosmos, time (*chronos*) was created. In the words of Plato: ‘The Demiurge began to think of making a moving image of eternity: at the same time as he brought order to the universe, he would make an eternal image, moving according to number, of eternity remaining in unity. This, of course, is what we call time’ (37d). In this way Plato affirms the relation of the temporal to the ontological, as Charles Upton noted: ‘The temporal unfolding of the universe is nonetheless a reflection, on a lower ontological level, of the eternal Hierarchy of Being as it exists on higher levels’ (2008: 191). Furthermore, ‘Time… came into being together with the universe so that just as they were begotten together, they might also be undone together, should there ever be an undoing of them. And it came into being after the model of that which is sempiternal so that it might be as much like its model as possible. For the model is something that has being for all eternity, while it, on the other hand, has been, is, and shall be for all time, forevermore’ (38b-c).

Plato also relates time to the wanderings of the celestial bodies: ‘Such was the reason, then, such the god’s design for the coming into being of time, that he brought into being the Sun, the Moon and five other stars, for the begetting of time. These are called wanderers (*planeta*), and they came into being to set limits to and stand guard over the numbers of time’ (38b). Proclus comments that time revolves as the first among things that are moved, bringing all things around in a circle (Cornford 1997: 104). It should be noted that time, strictly speaking, applies only to the realm of becoming. Time does not apply to the Forms, which are eternal (Cohen (2006). Accordingly, ‘Plato wished first to define time in order to contrast the temporal existence of even the everlasting gods with the unchanging duration of the eternal model’ (Cornford 1997: 117). In other words, the sensible world is the realm of time, whereas the intelligible world is the domain of eternity.

Throughout this first section of the creation account Plato has consistently reasoned from the metaphysical to the physical, as remarked by Gregory Vlastos (1975: 29). Thus the cosmos must have a soul, since the intelligible Living Thing has a soul; the cosmos must be unique, since its intelligible model is unique; the cosmos must be spherical, since the sphere is the most homogeneous shape and the homogeneous is ‘ten thousand time more beautiful’ than the heterogeneous (33b); and the cosmos must be characterised by time, since time is the moving image of eternity and as such brings a dimension of order into the unstable cosmic flux. Yet physical evidence is not disregarded; on the contrary, in his depiction of the celestial motions Plato avails himself of the best astronomical knowledge of his day (Vlastos 1975: 49-51).

According to Plato, every planet (including the sun and the moon) is a living creature with a body and an intelligent soul (38e). This notion is repeated in the *Laws* (898c-d) and confirmed by Proclus, Albinus and Chalcidius (Cornford 1997: 112). Furthermore, Proclus comments, the heavenly gods (i.e. Plato’s seven ‘wanderers’) participate in each of the three ‘moments’ of the noetic (i.e. related to intellect, *nous*) triad of Being, Life, and Intellect, but a different property predominates in each. Among the celestial bodies, the Moon is directed towards Life, ‘because Life comprehends within itself the whole of generation and proceeds as far as the ultimate recesses of the earth’ (*Commentary on Timaeus*; Dillon and Gerson 2004: 213).

Four kinds of living beings were made by the Demiurge, corresponding to the four primary elements (39e-40a). These are (i) the heavenly gods, in which the element of fire is dominant; (ii) the flying creatures (air); (iii) the aquatic creatures (water); and (iv) the terrestrial creatures (earth). It should be noted that the Demiurge himself makes only the heavenly gods, while the remaining three classes of living beings were made by these gods. Plato’s delegation of the rest of the creative work to the celestial gods may reflect a notion that the heavenly bodies, especially the Sun, actively generates life on Earth (Cornford 1997: 118, 141). Thus in the *Republic* the Sun is named as the cause of coming to be, growth, and nourishment of things in visible world, without itself coming to be (Book VI, 509b). Plato’s reference in the

Timaeus (40b) to 'living creatures everlasting and divine' (*zoa theia kai aidia*) includes the fixed stars and the planets, of which the Earth (*Gaia*) is the one with greatest seniority (40c). This statement has momentous ecological implications, since the Earth is then not a lifeless object to be exploited and desecrated by humankind.

The Athenian philosopher then depicts the coming-to-be of the gods (40d-41a). Referring to the other spiritual beings (*daimones*)[15], Plato again expresses caution regarding knowledge of the spiritual world: 'it is beyond our task to know and speak of how they came to be' (40d). However, 'following custom' the theogonic account of Hesiod is mentioned, from Earth and Heaven (*Ouranos*) to Zeus and Hera and their siblings. When all the gods had come to be, the Demiurge instructed them to make mortal beings (41a-d). The divine instruction is prefaced by the following declaration: 'O gods, works divine whose maker and father I am, whatever has come to be by my hands, cannot be undone but my consent.' This declaration by the Demiurge implies that the physical world exists on account of the divine Will – a conviction that would become paradigmatic in Christian and Islamic cosmology.

The instruction of the Demiurge to the gods, 'Weave what is mortal to what is immortal, fashion and beget living things' (41d), is followed by the creation of human beings. These are the only mortal creatures whose making Plato describes in detail, while the plants and lower animals are mentioned only briefly. Likewise, the physical differences between man and woman are postponed to near the end of the dialogue (90e-91d), since they are irrelevant to Plato's account of the common human nature (Cornford 1997: 141-142). We read in the *Timaeus* that the heavenly gods made human souls of the leftovers from the making of the world-soul, but of a lower grade of purity (41d). Each soul was assigned to a star (41e), so that the number of souls is the same as the number of stars. At death a just soul returns to its companion star, while an unjust soul is reincarnated for a second attempt (42b-c). In other words, those souls that fail to live honourable lives will reincarnate in mortal bodies of a lower order until they also live honourably (Dreyer 1975: 102). It appears that Plato understood the first incarnation of the soul as the same for all, namely as god-fearing living creatures. Thereafter, incarnations are determined by the soul either mastering the passions or being mastered by it, which is living in righteousness and unrighteousness respectively (41e-

[15] The Platonic notion of *daimones* should not be confused with the Christian teaching on demons or fallen angels. For Socrates and Plato, the *daimon* is the invisible companion of the soul from before its birth into this world, guiding the soul and reminding it of its true essence (Goosen 2007: 109-110).

42d). The soul is therefore responsible for any evil it may suffer – a notion that reflects the Socratic teaching that moral evil is the only real evil (Cornford 1997: 144).

Following the creation of the human soul, Plato describes the formation of the human body (44d-47e). He states that the gods made human bodies from a mixture of the four elements, namely fire, water, earth, and air. In other words, human bodies consist of the same elements as the material world (Dreyer 1975: 102) – an insight that has been confirmed by modern biochemistry. Descriptions are given by Plato of the creation of the head and limbs, of the making of the eyes and its function of vision, and of the purposes of seeing and hearing. Of the human body the head is created first by the gods, since it houses the immortal, rational part of the soul; then the torso as its vehicle and limbs for travelling and organs of sight to direct its movement (44d-45b). For Plato sight is not only useful for locomotion, but together with hearing reveal the harmony of world. These two senses are therefore necessary for well-being, the other senses only for existence (Cornford 1997: 151-152).

Plato reasons further that human knowledge begins with sight: 'As it is, however, our ability to see the periods of day-and-night, of months and of years, of equinoxes and solstices, has led to the invention of number, and has given us the idea of time and opened the path to inquiry into the nature of the universe. These pursuits have given us philosophy, a gift from the gods to the mortal race whose value neither has been nor will ever be surpassed' (47a-b). In other words, knowledge began with visual observation, which led to mathematics and finally to philosophy.[16] Plato's account of eyesight brings the reader to the point of contact between the knowing soul and the external world of visible bodies (Cornford 1997: 156). Likewise hearing is a gift from the gods, the account continues, both to enable speech and guided by intelligence to perceive the harmony in music, which is not given for the sake of irrational pleasure (47c-d). It is not difficult to surmise what Plato would have made of the cacophony that has characterised much of what has been presented as 'music' in the Western world since the early twentieth century.

[16] It was remarked in this regard by Oswald Spengler that some of the greatest Western mathematicians have been brought to their discoveries through a profound religious intuition, as was the case with Pythagoras and Plato. For example, Nicolaus Cusanus was guided from the notion of the divine infinity in nature to the elements of the Infinitesimal Calculus, and Leibniz from the infinite extent of the Godhead to his notion of *analysis situs* for the interpretation of pure space. Spengler adds, 'And Kepler and Newton, strictly religious natures both, were and remained convinced, like Plato, that it was precisely through the medium of number that they had been able to apprehend intuitively the essence of the divine world order' (1991: 52-52).

A distinction is made by Plato between actual and auxiliary causes during his discussion of the creation of human eyes. This distinction is firstly related to that between the invisible soul and the visible bodies of fire, water, earth and air (46d). In contrast to physical bodies which are devoid of reason (*logos*) or intellect (*nous*), soul possesses understanding. Plato continues, ‘So anyone who is a lover of understanding and knowledge must of necessity pursue as primary causes those that belong to intelligent nature, and as secondary all those belonging to things that are moved by others and that set still others in motion by necessity. We too, surely, must do likewise: we must describe both types of causes, distinguishing those that possess understanding and thus fashion what is beautiful and good, from those which, when deserted by intelligence, produce only haphazard and disorderly effects every time’ (46d-e). Plato here asserts that the physical elements are not the original causes of motion and thus of the world-order, since the only source of motion (*archē kinēseos*) is the soul (Cornford 1997: 162). That is to say, soul is the first cause of the becoming and the perishing of all things. If ‘nature’ means the generation of primary things, Cornford remarks, then soul has the best right to be described as existing ‘by nature’ (1997: 167). It is evident that the Platonic cosmology stands in stark contrast to the modern reductionist view that matter precedes the appearance of soul.

4.4 Mediation: the receptacle of becoming

After the preceding account of the creative role of the Demiurge, Plato introduces a third kind (*triton genos*) in the universe: ‘The earlier two [kinds] sufficed for our previous account: one was proposed as a model, intelligible and always changeless, a second as an imitation of the model, something that possesses becoming and is visible... Now, however, it appears that our account compels us to attempt to illuminate in words a kind that is difficult and vague. What must we suppose it to do and to be? This above all: it is a receptacle (*hypodochē*) of all becoming – its wetnurse (*tithene*), as it were’ (*Timaeus* 48e-49a). The introduction of a third kind fills a gap in the ontology that Plato obtained from Parmenides (as displayed in the *Republic*), i.e. knowable being and unknowable non-being. As commented by Francis Cornford (1997: 178), ‘If the perfectly real Forms are to have the objects of opinion as images, there must be something, not totally unreal, to receive these images.’ Since the created world is visible and tangible, Plato is required to postulate a three-dimensional field in which the universe may subsist (Zeyl 2009). The receptacle of becoming fills this need.

Plato first describes the nature of the receptacle and then illustrates it with examples from everyday life: ‘Now the same account, in fact, holds also for that nature which receives all the bodies (*somata*)… Not only does it always receive all things, it has never in any way whatever taken on any characteristic similar to any of the things that enter it… The things that enter and leave it are imitations of those things that always are [i.e. the Forms], imprinted after their likeness in a marvellous way that is hard to describe… We also must understand that if the imprints are to be varied, with all the varieties there to see, this thing upon which the imprints are to be formed could not be well prepared for that role if it were not itself devoid of any of those characters that it is to receive from elsewhere. For if it resembled any of the things that enter it, it could not successfully copy their opposites or things of a totally different nature whenever it were to receive them. … *This is why the thing that is to receive in itself all the elemental kinds must be totally devoid of any characteristics*. Think of people who make fragrant ointments. They expend skill and ingenuity to come up with something just like this [i.e. a neutral base], to have on hand to start with. The liquids that are to receive the fragrances they make as odourless as possible. Or think of people who work at impressing shapes upon soft materials. They emphatically refuse to allow any such material to already have some definite shape. Instead, they'll even it out and make it as smooth as it can be. In the same way, then, if the thing that is to receive repeatedly throughout its whole self the likeness of the intelligible objects, the things which always are – if it is to do so successfully, then it ought to be devoid of any inherent characteristics of its own... *But if we speak of it as an invisible and characterless sort of thing, one that receives all things and shares in a most perplexing way in what is intelligible, a thing extremely difficult to comprehend, we shall not be misled*. And in so far as it is possible to arrive at its nature on the basis of what we've said so far, the most correct way to speak of it may well be this: the part of it that gets ignited appears on each occasion as fire, the dampened part as water, and parts as earth or air in so far as it receives the imitations of these' (50b-51b; italics ours).

That is to say, the fire or water that we see is in reality the appearance within the receptacle of the Form of fire or the Form of water (Zeyl 2009). It has been remarked by Francis Cornford that Plato's receptacle is not that 'out of which' (*ex ou*) things are made, but rather that 'in which' (*en o*) qualities appear. It is therefore these qualities, not the receptacle as such, that constitutes the bodily, *to somatoeides* (Cornford 1997: 181). Proclus commented on Plato's account as follows: 'Perhaps it is better to say that the term 'things that pass in and out' (50c) is applied not only to the qualities, but also to the forms immersed in matter (*ta eidē ta enula*); for these, not the qualities, are likenesses (*homoiōata*) of the intelligible things' (quoted in Cornford 1997: 183). The 'forms immersed in matter' is in fact an Aristotelian phrase which to Proclus means the copies of the eternal Forms of fire, air, water, and earth. Moreover, the receptacle does not receive the eternal Forms, but instead receive all the likenesses of the four primary bodies (Cornford 1997: 183, 184, 186). That Plato's receptacle of becoming is indeed the universal Substance (*Prakriti*) of Indo-European metaphysics is evident when compared with the following characteristics of *Prakriti*: 'it is purely potential and passive, capable of every kind of determination, but never determining itself'; it is undifferentiated, imperceptible and undistinguishable, without possessing parts or qualities; and while *Prakriti* is the root of all manifestation, it requires the presence of *Purusha* (i.e. the Demiurge) to realise its productions (Guénon 1945: 50).

After thus introducing the receptacle, Plato affirms the basics of his ontology: 'For the moment, we need to keep in mind three types of things: that which comes to be [i.e. sensible objects], that in which it comes to be [i.e. the receptacle], and that after which the thing coming to be is modelled, and which is the source of its coming to be [i.e. intelligible Forms]. It is in fact appropriate to compare the receiving thing to a mother, the source to a father, and the nature between them to their offspring' (50c-d). Accordingly, there are three things that pre-existed the cosmos: the invisible realm of eternal and unchanging being; the sensible realm of becoming, which is always coming to be and perishing; and space (*chōra*), which always exists and is indestructible, providing 'a fixed state for all things that come to be.' These three realms are apprehended respectively by understanding, by opinion involving sense perception, and by a kind of 'bastard reasoning', as in a dream (52a-b). In addition to functioning as 'mother' or 'wetnurse', the receptacle is depicted here as invisible (*anoraton*), shapeless (*amorphon*), all receptive (*pandeches*), and 'not permitting itself to be destroyed' (Gerson 2005: 105). The fundamental principles of being, becoming, and space are thus contrasted by Plato in three respects: the mode of existence they have, the manner in which they are known, and the relation of Form and of copy to space (Cornford 1997: 193).

It is significant that this section of the *Timaeus* is linked by the Neoplatonists to a passage in the *Philebus*, where Plato declares that everything which now exists in the universe falls into one of four categories (Gerson 2005: 105). These are (a) the unlimited (*apeiron*), which admits of extremes of qualities or magnitudes; (b) the limit (*peras*), which imposes a quantitative ratio on the former; (c) the mixture (*symmisgomenon*) of the previous two, manifested for example in music and beauty; and (d) the cause of the mixture (*tes symmeixeos ten aitian*), which is intellect (*nous*) (23c-d). This reference to the infinite (or indefinite) is related to the concept of the receptacle in the *Timaeus* (Zeyl 2009). The difference between the *Timaeus* and the *Philebus* lies therein that the former depicts the universe prior to the imposition of order by the Demiurge, while the latter depicts the world after the work of the Demiurge is completed (Gerson 2005: 106). It is therefore erroneous to reduce Plato's cosmology in the *Timaeus* to an epistemology, as was done by Donald Zeyl (2009) with his suggestion that the three principles of being, becoming, and space are the components of Plato's analysis and not distinct ingredients.

As far as the crucially important notion of participation is concerned, Plato's introduction of the receptacle of becoming represents an advance on the metaphysics of the middle dialogues, in which the manner in which sensible objects participate in the Forms was largely left unexplained (Zeyl 2009). This perceived lack of clarity was one of the main grounds on which Aristotle criticized his Athenian mentor. For instance, in *On generation and corruption* the Stagyrite argues: 'If the Forms are causes, why is their generating activity intermittent instead of perpetual and continuous – since there always are Participants as well as Forms?' (Book II.9, 335b). It is our contention that Plato's postulation of the receptacle of becoming as a characterless entity that receives all characters from the Forms readily meets this objection by his eminent student.

4.5 Antithesis: the role of Necessity

In the next section of the *Timaeus*, Plato delineates the role of Necessity (*anangkē*; also translated force or constraint; L&S 58) in the generation of the world. Necessity, which is also named an errant cause, is associated not with order and intelligibility, but with disorder and random chance. Both Plato and Aristotle rejected Empedocles' view of nature as based on undirected chance and opposed to intelligible purpose (Cornford 1997: 165-166). What Plato terms Necessity entails the contributing causes (*synaitiai* or *symmetraitiai*) that contribute to the formation of the world by the Demiurge. These include the physical structures necessary for Intellect to achieve its purposes. The properties of these contributing structures are unalterable by the Demiurge, thus providing the reason why persuasion by Intellect is required for creation to take place (Zeyl 2009). Necessity is therefore a second principle (*arche*) in the origin of things (48b), in addition to Intellect. This implies that the divine Intellect is not omnipotent in its creative work, but is constrained by Necessity.

In his final dialogue, the *Laws*, Plato sketched the prevalence of Necessity in some of the

Presocratic cosmologies (Cornford 1997: 167). Some asserted that all things come into being partly by nature (*physei*), partly by chance (*tychē*), and partly by art, or skill (*technē*). They also claimed that the four elements exist by nature and chance, and bring into being the celestial bodies. These all move according to their several powers (*dynameos*), and interact 'by chance, of necessity' (*kata technē ex anangkēs*), from the combination of opposites. In this way is generated the heavens and all that is in them, including the animals and plants and the four seasons, not owing to intelligence or design, but by 'nature and chance' (*physei kai tychē*). This materialistic view was rejected by Plato, who argued that since soul precedes matter, likewise reason, art and law (*nomos*) are prior to the pairs of opposites such as roughness and smoothness, heaviness and lightness (*Laws* 888e-889c, 892a-c).

Plato's concept of Necessity should be distinguished from both the notion of natural law (which is instead related to the work of the Demiurge) and the modern understanding of necessity as something fixed and unalterable. In the *Timaeus,* Necessity means the indeterminate, the inconstant, and the anomalous. In other words, Necessity is a force that is irregular and unintelligible (Cornford 1997: 171-172). Plato accordingly mentions two types of causes, 'distinguishing those which possess understanding and thus fashion what is beautiful and good, from those which, when deserted by intelligence, produce only haphazard and disorderly effects every time' (46e). Moreover, Necessity resides in the properties of the elements: for example, fire has the characteristic power (*dynamis*) to produce burning heat. Since it is constrained by its own nature, Plato calls such causation 'wandering', i.e. without purpose (Cornford 1997: 174). The Demiurge uses these lower, auxiliary causes (*synaitia*) to produce the best result possible (46c).

By affirming the role of Necessity in the constitution of the cosmos, Plato does not reduce the body of the universe to mere extension, but admits that it contains active powers that are independent of the divine Intellect and are always producing undesirable effects. Since all physical motion proceeds from living soul, these chaotic powers represent an irrational element in the Word-Soul (Cornford 1997: 176). Therefore, the presence of Necessity in the cosmos should be recognised as an integral dimension of reality.

4.6 Synthesis: the co-operation of Intellect and Necessity

The third part of the *Timaeus* is devoted to a discussion of the physical cosmos, which is presented as the offspring of the union of Intellect and Necessity. Stated the other way round, Intellect persuades Necessity to form the initial universe: ‘For the generation of this universe was a mixed result of the combination of Necessity and Intellect. Intellect overruled Necessity by persuading her to guide the greatest part of the things that become towards what is best; in that way and on that principle this universe was fashioned in the beginning by the victory of reasonable persuasion over Necessity’ (48a; Cornford’s translation). Consequently, ‘That is why we must distinguish two forms of cause, the divine and the necessary’ (68e). It is our contention that Plato’s conception of the physical world as the result of co-operation between Intellect and Necessity represents an explanatory advance on the cosmology of Genesis in the Judaic and Christian traditions (‘And God saw that it was all good’), since Nature displays both design and purpose on the one hand and suffering and waste on the other.

Plato precedes his account of the formation of the physical universe with a vivid description of the initial chaos out of which the Demiurge creates the cosmos (52d-53c). This pre-existing chaos is both visible and in disordered motion, as mentioned earlier in the dialogue (30a), and is none other than the receptacle of becoming, prior to divine intervention (Zeyl 2009). It should be noted that the contents of the receptacle do not exist in the form of particles, which would be to read the atomism of Democritus into Plato (Cornford 1997: 200). This chaotic, pre-cosmic state consists of dissimilar forces (*dunameis*) that are constantly acting against each other, so that the filled space of the receptacle is always unstable (52e). At times the ongoing agitation in the receptacle produces manifestations appearing to be one of the four kinds (*gene*), such as air. In reality, these traces (*ichnē*) of the kinds are products of the receptacle, acting as a winnowing sieve (*plokanon*) that separates the heavy from the light (52e). Therefore, Zeyl (2009) writes, ‘The result is a pre-cosmic inchoate stratification of these traces, which anticipates the stratification of the finished universe.’ The task of the divine Craftsman is thus to transform the inchoate primordial matter from chaos into cosmos by imposing form onto it (Vlastos 1975: 70). That is to say, instead of creating out of nothing (*ex ouk onton*) the Demiurge creates out of formless matter (*ex amorphou hylēs*).

Initially the four ‘kinds’ (Plato prefers this term to ‘elements’) of fire, air, water, and earth are present in the receptacle, but without proportion and measure. They are ‘thoroughly god-forsaken’ in their natural condition, and therefore the Demiurge has to give these kinds their distinctive shapes, by means of forms (*eidesi*) and numbers (*arithmois*) (53a-b). In this way, Lloyd Gerson comments, ‘Plato is in his analysis of the cosmic sensible world separating off the mathematical contribution of the divinity from the pre-cosmic phenomenal chaos’ (2005:

240). The initial creative activity of the Demiurge regarding the sensible realm entails the fashioning of the elements according to specific geometrical figures known as regular solids. He thus chooses the tetrahedron for fire, the octahedron for air, the icosahedron for water, and the cube for earth (55e-56a). It should, however, be noted that in the Neoplatonic understanding the imposition of shapes and numbers by the Demiurge is mythical and not literal. Nevertheless, these 'shapes and numbers' used by the Demiurge to produce the cosmos out of chaos are the basic intelligible features of the world (Gerson 2005: 129, 219).

Plato further displays his Pythagorean inheritance when he argues that the basic building blocks of the cosmos are not the four kinds or the four solids, but rather two types of right triangles out of which the latter are constructed (Ferguson 2011: 133). Thus the faces of the cube consist of twelve isosceles triangles, while the faces of the tetrahedron, octahedron and icosahedron consist of equilateral triangles (four, eight and twenty, respectively). For the cosmos as a whole, the figure of the dodecahedron is selected, since it most closely resembles the shape of a sphere (55c). The dodecahedron consists of twelve pentagons, and together with the four mentioned figures represent the only regular solids, in which all the edges are the same length and all the faces are the same shape (Ferguson 2011: 133-134). Plato in all probability chose these regular solids in order to link the physics with the metaphysics of the dialogue, since the Forms of the four kinds have no perceptible properties. The Demiurge thus 'imitates' the eternal, immaterial and imperceptible nature of the Forms of fire, air, water, and earth by producing transient, material and perceptible instances of the four kinds (Zeyl 2009).

In his *Commentary on Timaeus*, Proclus summarises the sequence of cosmic creation as follows. First the body of the universe is constructed 'through being carved up by forms and demiurgic sectionings and divine numbers.' The soul of the universe is then produced by the Demiurge and filled with harmonic reason-principles (*logoi*) and divine, creative symbols. Finally, Proclus adds, 'the whole Living Being is woven together in accordance with the unified plan of the universe present in the intelligible realm' (quoted in Dillon and Gerson 2004: 335). Parts such as individual souls are settled within the whole and become embedded in the universe, and mortal beings are made by the agency of the heavenly gods (Dillon and Gerson 2004: 336).

The next section of the *Timeaus* depicts the constitution of the human being and the causal principles of its being (69c-76e). In Book IV of the *Republic* Plato introduced the various elements, or parts, of the individual soul: the highest is reason, the lowest is appetite, and in between is *thymos*. The latter term is translated as any vehement passion, anger, or wrath, and in the good sense as spirit or courage (L&S 323). Now, in the *Timaeus*, Plato depicts the creation of the soul's elements, as at least being 'a likely account' (72d). The highest element, reason, is the immortal part of the soul and is therefore situated in the head, which is 'the most divine part of us, and the master of all our other parts' (44d). Following the example of the Demiurge in his construction of the universe (i.e. combining the immortal with the mortal), the gods encased the immortal (i.e. rational) soul within the human head and gave it the entire body as its vehicle. Within the body they then built another kind of soul, namely a mortal one which comprises pleasure, pain, courage, fear, anger, expectation, lust, and unreasoning sense-perception. The spirited part of the mortal soul was placed in the top third of the torso between the midriff and the neck, in order to be closer to the head and the dictates of reason. Finally, the appetitive part of the soul was placed in the middle part of the torso, between the midriff and the navel, being unamenable to reason (69c-d, 70a, 70d-e, 71a).

As reflection of the intelligible and sensible realms of the cosmos, Plato thus conceived of the human being as consisting of two main components that differ essentially. On the one hand, there is the soul which participates in the realm of Ideas, and which is immortal and the bearer of Intellect. On the other hand, there is the body which is part of the sensible world, and which is mortal and represents the principle of Necessity in the human being (Dreyer 1975:102). This anthropology of Plato would exercise immense influence on Christian thought, in both the Greek and Latin traditions.

Following the creation of the human being, Plato discusses its relation with the plant kingdom (77a-b): 'They [i.e. the gods] made another mixture and caused another nature to grow, one congenial to our human nature though endowed with other features and other sensations, so as to be a different living thing. These are now cultivated trees, plants and seeds, taught by the art of agriculture to be domesticated for our use. But at first the only kinds there were were wild ones, older than our cultivated kinds. We may call these plants "living things" (*zōa*) on the ground that anything that partakes of life has an incontestable right to be called a "living thing."' Plato is here arguing that since plants have life they ought to be called living things, even though they are not animals (Zeyl 1997: 1277).

Plato relegated human sexual differentiation and the creation of the lower animals to the final paragraphs of the *Timaeus*. Plato's motive for doing so is his odd belief that women and animals such as birds, terrestrial animals and aquatic animals serve as bearers for the souls of men who have failed to live a virtuous life during their initial incarnation (90e, 91a, 91d-e, 92b). Of far more interest to us is the final sentence of the dialogue's penultimate paragraph: 'Thus, both then and now, living creatures keep passing into one another in all these ways, as they undergo transformation by the loss or by the gain of reason and unreason' (92b-c; translation in Theodossiou et al 2011: 96). When this statement is viewed together with the earlier passage on the creation of plants (77a-b), Plato seems to conclude that there is no essential difference among the three main categories of living creatures, namely humans, animals, and plants. This appreciative stance towards our non-human relatives is reflected in the dialogue *Statesman*, where Socrates' visitor declares that there are two classes of living creatures, namely human and animal (263c; Theodossiou et al 2011: 96).

According to Proclus, in the final section of the dialogue (76e-92c) Plato aligns his concerns with those of other natural philosophers – that is, the Presocratics (Dillon and Gerson 2004: 337). As a matter of fact, the author of the *Timaeus* incorporates insights from several of the most important Presocratics, especially Pythagoras, Heraclitus, Parmenides, and Empedocles, while modifying their teachings according to his theistic cosmology (Cornford 1997: 57). He thus employs the four-fold scheme of the elements first postulated by Empedocles, but re-interprets it in terms of mathematical objects. Continuing the Pythagorean teaching, Plato argued that the Ionian elements are generated from geometrical figures that are elemental, with even these being reducible to numbers (Cornford 1997: 162). Therefore, while agreeing with the Pythagoreans that the physical universe was fundamentally mathematical, Plato based his system in the *Timaeus* on geometrical figures (Cohen 2006). This preference was also displayed on the sign above the entrance to Plato's Academy: 'Let none ignorant of geometry enter here' (Lundy 2010: 63). In other words, the cosmogonic sequence entails a movement from the Forms through geometrical figures into physical bodies.

Plato concludes the *Timaeus* with an eulogy to the created order: 'And so now we may say that our account of the universe has reached its conclusion. This world of ours has received and teems with living things, mortal and immortal. A visible living thing containing visible ones, perceptible god, image of the intelligible Living Thing, its grandness, goodness, beauty and perfection are unexcelled. Our one universe, indeed the only one of its kind, has come to be' (92c). As commented by Proclus, the dialogue mingles the demonstrative and the dogmatic characters. This is done so that we can comprehend natural phenomena from both the physical and theological points of view, 'in imitation of the nature of which it presents a study' (quoted in Dillon and Gerson 2004: 339). Indeed, in the Platonic tradition there is no question of a separation of the physical from the metaphysical – a conviction that is sadly lacking in much of the modern scientific enterprise.

4.7 Conclusion

Although Plato has for centuries been recognised as the father of Western philosophy, to the extent that Alfred Whitehead famously described the whole course of European philosophy as a series of footnotes to Plato, he simultaneously preserved the Indo-European tradition of religious philosophy, which naturally includes the Presocratic cosmology. It has been remarked, for example, that much of Plato could be viewed as a series of comments on Parmenides (Blackburn 2008: 268). The Athenian thinker also continued the Pythagorean themes of the mathematical structure of the world and the immortality of the soul. In fact, for centuries after his death Plato was viewed as a Pythagorean, with no attempt made (except for Aristotle) to distinguish between Platonism and Pythagoreanism (Ferguson 2011: 159). It was further asserted by Francis Cornford that the theory of Forms and the notion of the immortality of the soul constitutes the 'twin pillars' of Platonism. However, Lloyd Gerson correctly cautions, the latter should not be confused with the concept of personal immortality as is found in some religions (2005: 289).

The combined legacy of Pythagoras and Plato has from the outset been as much theological as it is philosophical, as much soteriological as it is epistemological, as much mystical as it is ethical. This ultimately theocentric approach has been vividly described by Algis Uzdavinys: 'The ultimate goal of Pythagorean and Platonic philosophy was assimilation to God through the cultivation of truth and virtue. It meant a return to the first principles reached through philosophical education (*paideia*) and recollection (*anamnesis*), scientific investigation, contemplation, and liturgy (or theurgic ascent), based on the ineffable symbols and sacramental rites. By this philosophical practice the initiate student was transformed into a saintly and divine man (*theios aner*)' (2004: xxvi). That Platonism is a religious philosophy of the most exalted order is abundantly evident.

5: Aristotle

5.1 Introduction

Born in the Greek town of Stagira,[17] Aristotle (384-322 B.C.) was attached to Plato's Academy in Athens for a period of around twenty years, from 367 until 347 B.C. After the death of his illustrious mentor, Aristotle left Athens and served for several years as tutor to the youthful Macedonian prince who was destined to achieve lasting fame as Alexander the Great. Aristotle returned to Athens in 335 B.C. and founded his own school, the Lyceum, in a grove dedicated to Apollo Lyceus. When Alexander died in 325 B.C., Aristotle left Athens for the second and last time. Together with Plato, Aristotle is recognised as the most influential of all Western philosophers (Blackburn 2008: 23).

Not long after Athens was captured by the Romans in 87 B.C. the extant writings of Aristotle were brought to Rome. In the new imperial capital these works were edited, organised and published by Andronicus of Rhodes, who thereby initiated the 'Aristotelian renaissance' of the first century B.C. (Moraux 1973: 45). Aristotle divided the sciences into three distinct types: theoretical, practical, and productive sciences, of which only the first is relevant to our thesis. In their turn the theoretical sciences are subdivided into theology (or metaphysics), physics, and mathematics – dealing with substances unconnected with matter, natural bodies, and numbers and spatial figures, respectively (*Metaphysics* VI.1025b-1026a; Ross 1995: 65). Mathematics is the science dealing with quantity (*to poson*), or that which is divisible (*diaireton*) – the latter being either discrete or continuous. While arithmetic deals with discrete quantities, i.e. numbers (*arithmoi*), geometry deals with continuous quantities, i.e. magnitudes (*megethē*) (*Categories* 4b-5a; Gerson 2005: 233-234). For Aristotle theology is the first and highest science, since it 'deals with things which both exist separately and are immovable' – that is, the realm of the divine (*Metaphysics* VI.1026a). We will first survey relevant aspects of Aristotle's physics and metaphysics, followed by a delineation of his bio-philosophy, and culminating in a discussion of his teleology.

5.2 Physics and metaphysics

Aristotle's works dealing with the physical world are the *Physics, On the Heavens, On Generation and Corruption*, and *Meteorology*. The treatises comprising his *Metaphysics* are

[17] Also rendered as Stagyra – hence the customary referral to Aristotle as the Stagyrite.

titled in Greek *ta meta ta physika*, which means 'after the physics', since it follows upon Aristotle's writings on natural phenomena. Metaphysics is postulated as the first science, or first philosophy (*prote philosophia*): its object of study is being as such and the attributes which belong to being (IV.1003a; Dreyer 1975: 128-129). It is noteworthy that although highly critical of Hellenic thinkers from Plato onwards, Martin Heidegger suggested that Aristotle preserved an echo of the original Hellenic conception of Being in this seminal work. In his *Introduction to Metaphysics* the German philosopher approvingly quotes the following extract from the *Metaphysics* (IV.1003a): 'Now since we are seeking the principles and the highest causes [or grounds], it is clear that these must belong to some nature (*physis*) in virtue of itself. If, then, those who were seeking the elements of beings [*ton onton*] were also seeking these principles, these elements too must be elements of being [*tou ontos*], not accidentally, but as being. Accordingly, it is of being as being that we, too, must find the first causes' (2000: 17). Aristotle's metaphysics is evidently grounded in ontology, as was the case with Parmenides and Plato among his predecessors.

Aristotle postulated ten categories which are incomposite, namely substance, quantity, quality, relation, place, time, position, state, action, and affection (*Categories* 4.1b). The kinds of essential being (*ousia*) are precisely those indicated by the categories, so that there are ten senses of being (*Metaphysics* V.1017a). This statement by Aristotle is related by Thomas Aquinas to the word essence (*esse*) as the Latin equivalent of *ousia*, denoting 'that which makes something what it is.' Thomas adds that this conception of essence is the same as *form*, which the Islamic scholar Ibn Sina explains as that which gives a thing its stable identity. In composite substances the essence is expressed by a composite of matter and form, and not by either of the two as such (*On Being and Essence*; McDermott 1993: 91-94).

It has been remarked by René Guénon that Aristotle's categories apply only to our world and its conditions, so that 'quality' appears as the correlative of 'quantity.' The Scholastic 'form' is thus the equivalent of the Aristotelian *eidos*, although the latter term also signifies 'species', thereby denoting the essence that is common to an indefinite number of individuals. Therefore the specific nature of a thing is purely qualitative, since it is not affected by quantity (Guénon 1995: 22). That is to say, for both the Hellenic philosophers and the Scholastic theologians, form is the qualitative seal imprinted on matter by the unique essence of a being or a thing. This is the notion of hylomorphism (i.e. the conjunction of matter and form in all existing things), in terms of which multiplicity and quantity exist only at the level of 'material' reflections of the archetype, or form (Burckhardt 1974: 129, 141). The relation between quality, form and matter has been perceptively related to the beauty of flowers by Lord Northbourne. Remarking that the ephemeral nature of flowers is counterbalanced by their rhythmic renewal, the British traditionalist writes: ‘This year’s dog-rose is not the same as last year’s, but its beauty is the same; the quality is eternal, only its manifestation in a material form is ephemeral’ (Northbourne 1995: 104-105).

5.2.1 Natural and artificial

To begin with, a distinction is made by Aristotle between things which exist by nature from those which do not. As explained in the *Physics*, ‘Of things that exist, some exist by nature, some from other causes. ‘By nature’ the animals and their parts consist, and the plants and the simple bodies (earth, fire, air, water)... Each of them has within itself a principle of motion and of stationariness (in respect of place, or of growth and decrease, or by way of alteration’ (II.192b). In the case of artificial things, on the other hand, ‘None of them has in itself the source of its own production’ (II.192b). In other words, while natural things have an internal principle of motion (and rest), artificial things such as houses are produced by an external principle. Aristotle adds that each natural thing is a substance, ‘for it is a subject, and nature always implies a subject in which it inheres’ (*Physics*, II, 192b). When speaking of ‘nature’, it could refer to either ‘the immediate material substratum of things which have in themselves a principle of motion or change’, or ‘the shape or form which is specified in the definition of the thing’ (193a). However, while ‘nature’ entails both matter and form, priority is given to form: ‘The form indeed is “nature” rather than the matter; for a thing is more properly said to be what is is when it has attained to fulfilment than when it exists potentially’ (193b).

For Aristotle both natural and artificial things are compounds of matter (*hylē*) and form (*morphē*). In other words, they are hylomorphic compounds. There is, however, a significant qualification in this regard: whereas the form of artificial products is represented by their shape or structure, in the case of living beings it is the soul that constitutes the form. And since for Aristotle form is more important than matter in the composition of things, living beings can survive changes in their material bodies, but if the soul is changed (as at death) the being ceases to exist (Reeve 2001: xvi). The distinction between natural and artificial things is further explained by Aristotle in terms of movement and necessity. Physical nature moves by necessity, for example a growing tree. Artificial things, for example sculptures, entail movement but not necessity, and are thus not part of nature (Dreyer 1975: 138). Within natural things a further distinction is made by Aristotle: 'Of things constituted by nature some are ungenerated, imperishable, and eternal, while others are subject to generation and decay. The former are excellent beyond compare and divine, but less accessible to knowledge' (*Parts of Animals* I.644b). These realms pertain to the celestial and the terrestrial respectively, being the main division in Aristotle's cosmology.

5.2.2 Substance

Aristotle conceives of substance (*ousia*; also rendered the 'being' or 'essence' of a thing; L&S 507) as the primary category of reality. It is defined as follows: 'Substance, in the truest and primary and most definite sense of the word, is that which is neither predicable of a subject nor present in a subject; for instance, the individual man or horse. But in a secondary sense those things are called substances within which, as species, the primary substances are included; also those which, as genera, include the species. For instance, the individual man is included in the species "man", and the genus to which the species belongs is "animal"; these, therefore – that is to say, the species "man" and the genus "animal" – are termed secondary substances' (*Categories* 5.2a). The scope of the concept 'substance' is elaborated in the *Metaphysics*: 'Substance is thought to belong most obviously to bodies; and so we say that not only animals and plants and their parts are substances, but also natural bodies such as fire and water and earth and everything of the sort, and all things that are either parts of these or composed of these (either of parts or of the whole bodies), e.g. the physical universe and its parts, stars and moon and the sun' (VII.1028b). All things that exist in the physical sense are evidently viewed as substances.

Regarding the primary sense of substance, we read in the *Categories*: 'All substance appears to signify that which is individual' (5.3b). That is to say, substance is understood primarily as individually existing reality (Dreyer 1975: 130). While substance in the primary sense of the word refers to an individual man or horse, substance in the secondary sense refers to the species (which includes primary substance) and the genus (which includes the species). In addition, primary substances are called that on account of being entities which underlie everything else. Of secondary substances, the species is more truly substance than the genus, since it is more closely related to primary substance. Moreover, Aristotle reasoned, species and genus do not merely indicate quality, for example the term 'white' – rather they determine quality with reference to substance (*Categories* 5.2b; 5.3b).

Aristotle does not view substance as immutable. In the *Categories* he argues that while substance remains numerically one and the same, it is capable of admitting contrary qualities at different times, such as hot and cold. This capacity for change is due to the modification taking place within substance itself (5.4a-b). However, although substance admits of modification, it is incapable of movement: 'In respect of substance there is no motion, because substance has no contrary among things that are' (*Physics* V.225b).

Aristotle's notion of substance may be analysed from two perspectives: form and matter, and potency and actuality (Dreyer 1975: 130). The former also pertains to the mathematical level, since both number and magnitude consist of form and matter. In the case of number, its matter consists of its units and its form is the precise number that it is. In the case of a magnitude such as a triangle, its matter is its three straight lines, while their position as sides in a plane and the angularity of these sides represent the form of the triangle (*Metaphysics* XIII.1084b; Gerson 2005: 234).

5.2.3 Form and matter

From a static perspective, each substance consists of form (*eidos*) and matter (*hylē*). In the *Metaphysics* Aristotle illustrates his argument by means of a bronze statue: the matter is the bronze, the form is the shape or pattern, and the concrete whole (i.e. substance) is the statue. However, the form is prior both to the matter and the compound (VII.1029a). This affirmation by Aristotle that the form of sensible composites has more being than the matter or the composite itself is harmonious with Plato's notion that eternal substances have 'more being' (*mallon onta*) than sensible substances, as is referred to in the *Metaphysics* (VII.1028b; Gerson 2005: 195). It has been remarked by Thomas Aquinas, the leading Aristotelian commentator in the Latin Christian tradition, that composite substances realise essence in a third way, after those of God and the intelligences. Consisting of matter and form, composite things acquire their existence from another and their nature from demarcated material. Thus they are limited both above and below, in contrast to intellectual substances which are limited above but unlimited below (*On Being and Essence*; McDermott 1993: 109).

Matter is defined by Aristotle as 'the primary substratum (*to proton hypokeimenon*) of each thing, from which it comes to be without qualification, and which persists in the result' (*Physics* I.192a). In the same passage it is stated that form cannot desire itself since it is without defect, but matter desires form, as the female desires the male and the ugly desires the beautiful. Elsewhere Aristotle reasons that both natural and artificial things have matter, which possesses the capacity of both being and not-being. While natural things are produced by their formal nature, artificial things proceed from the form which is present in the soul of the artist (*Metaphysics* VII.1032a-b).

The Aristotelian notion of primary matter (*hylē*) was embroidered by Thomas Aquinas. Primary matter does not pertain to the bronze of a statue, for example, since the bronze is already formed matter. Instead, Thomas argues, only material subject to form but having no particular form can be called primary matter. Therefore, since we know and define things by their forms, primary matter cannot be known or defined except by way of analogy. Another implication hereof is that nothing actually existing can be called primary matter (*On the Principles of Nature*; McDermott 1993: 70-71). Aristotle employs both of the terms *morphē* and *eidos* to signify form, but generally *morphē* indicates sensible shape and *eidos* intelligible structure. Further terms used as synonyms for *eidos* are *logos*, the formula or definition, and *to ti ēn einai*, literally ‘the what it was to be so and so’, that is to say the essence (Ross 1995: 76). Evidently for Aristotle the term *eidos* indicates the Platonic Form, albeit always viewed in conjunction with matter.

While matter expresses individuality, form expresses generality for Aristotle. It therefore determines the essence (*ousia*) of a thing (Dreyer 1975: 131). Or as affirmed by Boethius, it is by its form that a thing is known, ‘form being like a light by which we know what that thing is’ (*De Unitate et Uno*; quoted in Burckhardt 1974: 135). Aristotle viewed matter without form as indescribable, since only form provides differentiation in substance (Blackburn 2008: 225). That is to say, matter is a relative term, and to each form there corresponds a special matter (*Physics* II.194b). Thus in nature, the elements are matter relative to their simple compounds, namely tissues; the tissues are matter relative to the organs; and the organs are matter relative to the living body (Ross 1995: 76).

The Aristotelian hierarchy of forms in nature is related by Thomas Aquinas to the activities peculiar to those forms. Firstly, the activities of elemental forms (which are the closest to matter) do not transcend the physico-chemical level. Next come the forms of compounds, which in addition to elemental activities display behaviour specific to their own natures, such as the magnetic properties of iron. On the next level we find the souls of plants, which are also capable of moving themselves. Above them are the souls of lower animals, which possess not only self-movement but also knowledge, albeit of a material kind for which they require bodily organs. On the highest level (Thomas limits this discussion to the human soul) there are the life-principles of human beings, which resemble the higher substances in their capacity for understanding also immaterial things. However, Thomas argues, human souls acquire immaterial, intellectual knowledge from the knowledge of material things through the senses, and therefore the human soul has to be united with a body in order to have a complete specific nature (*Quaestio Disputata de Anima*, 1; McDermott 1993: 188-190).

Aristotle's notion of the relation between form and matter is problematic from a Platonic viewpoint. Since formless matter cannot have its origin or principle in the Divine, which is conceived by Aristotle as perfection of form, it must be pre-existent and non-divine. Further, since what possesses form possesses reality, formless matter is unreal. In this way, Philip Sherrard contends, an absolute dualism is established by Aristotle between form and formless matter, with no principle recognised as embracing both (2002: 7). However, the divergence between Plato and Aristotle in this regard could be attributed to their metaphysical points of departure, namely the world of Forms and the world of concrete things, respectively. Thus Plato emphasises the participation (*methexis*) of sensible things in the Forms, whereas Aristotle focuses on the self-appearance of substance (*ousia*). Yet in the final analysis Aristotle agrees with his teacher that sense-perception has to be transcended by thought in order to grasp the full substance of reality (Goosen 2007: 201-202).

One of Aristotle's criticisms of the Platonic theory of Forms pivots on the relationship between individuality and universality. For instance, in the *Metaphysics* it is argued, 'If they [the Forms] are universal, they will not be substances; for everything that is common indicates not a "this" but a "such", but substance is a "this"... If, then, the principles are universals, these results follow; if they are not universals but of the nature of individuals, they will not be knowable; for the knowledge of anything is universal' (III.1003a). Later in the same work Aristotle adds another objection: 'Further, that which is one cannot be in many places at the same time, but that which is common is present in many places at the same time; so that clearly no universal exists apart from its individuals. But those who say the Forms exist, in one respect are right, in giving the Forms separate existence, *if* they are substances; but in another respect they are not right, because they say the one over the many is a Form' (VII.1040b). In this way, 'they at the same time make the Ideas universal and again treat them as separable and as individuals' (XIII.1086a). With these arguments Aristotle presented a dilemma to the Platonists, as remarked by Lloyd Gerson: 'If they wish to insist that the Form is a separate individual, then they must give up the primary function of a Form which is to be a one-over-many. If, on the other hand, they wish to maintain this function, then they can no longer insist that the Form must be a separate individual' (2005: 221).

However, it is our contention that the Sholastic reading of Aristotle's ontology is eminently compatible with Plato's theory of Forms. In his discussion of the diversity of essence in God, intelligences, and material things, Thomas Aquinas writes that (created) intellectual substances (i.e. intelligences), although having an immaterial essence, do not have a stand-alone existence (as God has) but an acquired existence. Aristotle described intelligences as unlimited below but limited above; as explained by Thomas, the intellectual substances are 'limited in existence which they acquire from above, but unlimited below since their forms are not limited to what some acquiring material can take on' (*On Being and Essence*; McDermott 1993: 107). This notion of the intelligible realm is similar to Plato's conception of the Forms as acquiring their existence from above (i.e. the Good), while being unlimited in their effects on the sensible world below.

Furthermore, in the Neoplatonic understanding Aristotle did not reject the notion of paradigmatic causality, that is to say the generative role of the Forms. We find Simplicius, for example, reasoning as follows: 'I think that it is possible to use Aristotle's assumptions (*hypothesesi*) to show that the causes of [enmattered] forms are distinct (*diōrismena*) from them and are paradigms of them. We say that the natural things exist as a result of the participation of matter and form, with the matter participating in the form according to an internal participation (*kata tēn en autē methezin*)' (quoted in Gerson 2005: 119).

The abstraction of Forms from sensible objects constitutes Aristotle's notion of universals (Sherrard 2002: 9). Commenting on Aristotle's abstracting of forms from their material conditions (since in conjunction with matter the forms are not understandable), Thomas Aquinas contends that this is why we have to acknowledge the existence of an agent mind (*Summa Theologiae*, 1a79; McDermott 1993: 146-147).[18] Whereas for Plato the universals (i.e. the Forms) exist independently of things, for Aristotle the universals exist in things but not independently of them (Blackburn 2008: 374). Therefore for Aristotle knowledge of

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18 That is to say, Mind as efficient cause.

universals is viewed as the most complete knowledge humankind can have of the Divine, being free from all matter. Accordingly, as argued by Sherrard, for Aristotle ‘the more rationality an object possesses, the greater is its degree of reality, and hence its value, and this whether the object in question is an institution, a work of art, or the conduct of human life; and, of course, the converse is true as well’ (2002: 9). In other words, speaking *grosso modo*, Aristotle equated the rational with being and by implication the irrational with non-being.

Nevertheless, to associate Aristotle with rationalism as the latter has been understood since the ‘Cartesian revolution’ would be erroneous. On the one hand it should be admitted that whereas Plato expressed sacred truths in discursive rather than intuitive language, Aristotle strove to provide rational bases for the truth itself. On the other hand, the rationality of Aristotle is grounded in metaphysical certitude, and thus tends upwards and not downwards as was the case with the Sophists and Atomists, for instance (Schuon 1984: 64, 66). As a result, certain basic ideas in Aristotle, such as the distinction between matter and form, are derived from a supra-rational knowledge which is timeless. In the words of Jacob Burckhardt, ‘Aristotle translates this wisdom into a homogeneous dialectic. His dialectic is valid because the law inherent in thought reflects in its own way the law of existence. At the same time he demonstrates reality only in such measure as it is able to be logically determined. Plato and Plotinus go much further; they reach beyond the “objectivized” cosmology of Aristotle, restoring to symbolism all its suprarational significance’ (1974: 123).

Aristotle’s refusal to divorce the physical from the metaphysical is evident from the opening sentence of *On the Heavens*, where he declares that the science of nature concerns itself with bodies and magnitudes, their properties and movements, and their principles. He adds: ‘For of things constituted by nature some are bodies and magnitudes, some possess body and magnitude, and some are principles of things which possess these’ (I.268a). Therefore natural science deals not only with the elements, but also with animate things such as plants and animals, and their principles such as matter, form, movement, and soul (Stocks 2001: 398).

5.2.4 Potency and actuality

From a dynamic perspective, each substance consists of potency and actuality. The terms potency and potentiality are derived from the Latin *posse*, ‘to be able’, from which also derives *possibilis*. Accordingly, to be potent means to be rich in possibilities (Schuon 1982: 43). The Greek term *dynamis* primarily means power, and Aristotle distinguishes two senses thereof in the *Metaphysics*: the power to produce change in something else (VIII.1046a); and the potentiality in a thing to pass from one state into another, such as a statue out of wood (VIII.1048a). For Aristotle actuality is prior to potentiality, both logically and in reality; that is to say, in all substance the potential is rooted in the actual (Ross 1995: 183). Or, as lucidly stated by Thomas Aquinas, ‘Some things are, while some things can be, but aren’t. We say that what can be exists *potentially*, and what already is exists *actually*’ (*On the Principles of Nature*; McDermott 1993: 67).

Aristotle credits Anaxagoras (with his notion of mind) and Empedocles (with his doctrine of love and strife) among his predecessors for recognising the priority of actuality over potency (*Metaphysics* XII.1072a). The priority of the actual over the potential exists in various senses, namely formula, time, and substantiality. Thus, ‘from the potentially existing the actually existing is always produced by an actually existing thing, e.g. man from man’ (*Metaphysics* IX.1049b). The priority of actuality over potency also harbours teleological implications, Aristotle adds, ‘because the things that are posterior in becoming are prior in form and substantiality (e.g. man is prior to boy and human being to seed; for the one already has its form, while the other has not), and because everything that comes to be moves towards a principle, i.e. an end (for that for the sake of which a thing is, is its principle, and the becoming is for the sake of the end), and the actuality is the end, and it is for the sake of this that the potency is acquired. *For animals do not see in order that they might have sight, but they have sight that they may see*’ (IX.1050a; italics ours).

The priority of actuality over potentiality in substance is further argued by Aristotle with reference to eternal things: ‘for eternal things are prior in substance to perishable things, and no eternal thing exists potentially... Nothing, then, which is in the full sense imperishable is in the full sense potentially existent; all imperishable things, then, exists actually’ (*Metaphysics* IX.1050b). In the same passage it is added that the impossibility of potential existence applies likewise to anything which is of necessity and to eternal motion, if such exists. ‘Obviously, then,’ Aristotle concludes, ‘actuality is prior both to potency and to every principle of change’ (IX.1051a). Nonetheless, we contend that the priority of the actual over the potential does not limit the latter in any way. As stated in theistic terms by Lord Northbourne, ‘The power of God, as our text[19] states so clearly, comprehends all possibility, and all possibility is infinitely

19 I.e. the Biblical statement that with God all things are possible (Mark 10:27).

more than all actuality; and we can never perceive more than a small fraction even of actuality, let alone of possibility' (1995: 113).

Matter is associated with potency and form with actuality, as Aristotle states in the *Metaphysics*: 'Further, matter exists in a potential state, just because it may come to its form; and when it exists actually, then it is its form' (IX.1050a). Thomas Aquinas comments that anything potential can be called material, while anything that gives existence can be called form. And since forms make things actual, forms are called actualisations or acts. Matter can never exist by itself (i.e. devoid of form), which is to say that matter by itself never exists actually but only potentially (*On the Principles of Nature*; McDermott 1993: 68, 71). Therefore, since matter is identified with potency and form with actuality, to actualise a possibility is the same as to give form to matter. A particular matter only contains certain possibilities, and therefore matter depends on form for its realisation (Dreyer 1975: 133). The Aristotelian notion of the interaction between potency and actuality has also been stated as follows: when a being has exceeded its state of potentiality and attained to its highest goal, namely pure actuality, it can be viewed as a fully realised being (Goosen 2007: 202-203).

Important terms for Aristotle with respect to actuality are *energeia* and *entelechia*. The former means an action, operation, or energy (L&S 224). The term *energeia* was created by Aristotle, based on his conception of the sciences, philosophy, and the world of phenomena as being interdependent (Theodossiou et al 2011: 96). To be more precise, 'The term *hē energeia* was invented by Aristotle to indicate a sort of *kinēsis* that is without imperfection, that is, potency' (Gerson 2005: 217). The noun *entelechia* appears to be a composition of the adjective *enteles* (i.e. complete, entire, or perfect; L&S 228) and the verb *echein* (to have), thus meaning the attainment of completion or perfection. Therefore, *entelechia* entails the completed reality of substance (O'Rourke 2004: 13). Since purpose is essential to form in the Aristotelian conception, reality entails the attainment of purpose. This attribution of purpose to substantial reality reflects Aristotle's teleological vision, which will be outlined later in this chapter.

5.2.5 Causality

Regarding causality, Aristotle affirms his Platonic inheritance in the *Metaphysics*: 'But evidently there is a first principle, and the causes of things are neither an infinite series nor infinitely various in kind' (II.994a; Gerson 2005: 187). All existing things come into being through the interaction between specific causes, of which four kinds are distinguished. They are known as material, formal, efficient, and final causes, although Aristotle himself did not employ these terms. The kinds of causes are as follows: (a) the material cause is the immanent material out of which a thing comes to be and which persists; (b) the formal cause is the form, pattern or archetype, i.e. the definition of the essence and the parts in the definition; (c) the efficient cause is the primary source of the change or coming to rest; and (d) the final cause is the end or aim for the sake of which a thing is (*Physics* II.194b; *Metaphysics* V.1013a).

For Aristotle all causes could be either potential or actual. While actual causes cease to exist simultaneously with their effects, in the case of potential causes (e.g. house and builder) this is not always true. Aristotle insists that in investigating the cause(s) of each thing it is necessary to seek what is the most precise, as should indeed be the case in all things. Moreover, generic effects should be assigned to generic causes and particular effects to particular causes (*Physics* II.195b). That is to say, effects must have causes proportionate to them, as commented by Thomas Aquinas (McDermott 1993: 279). The Aristotelian notion of causality was related by Aquinas to the originative principles in nature. Nature has three principles, namely matter, form, and lack of form, but these are not enough for generation to occur. What exists potentially cannot bring itself to actualization; in other words, form cannot draw itself out of potentiality into actuality. For example, copper is potentially a statue, but it needs a craftsman to draw it into actuality. Therefore, in addition to form and matter an active principle is required, which is called the efficient cause or mover or agent. Finally, there must be a fourth thing towards which the agent tends, namely the goal (i.e. purpose). Thomas emphasises that every agent, whether it acts by nature or by will, tends towards a goal, even if it is unaware of its goal. The four causes are therefore material, efficient, formal, and final (*On the Principles of Nature*; McDermott 1993: 71-72).

It has been remarked by some commentators that not all existing things are caused by one or more of Aristotle’s four causes. For example, an event such as a flash of lightning is caused but not made of material, is not made according to a blueprint, is not the result of (intelligent) agency, and is apparently without purpose (Blackburn 2008: 57). However, we contend that a flash of lightning is precisely an *event* and not an *object*, whether natural or artificial, and therefore this recognition does not invalidate the Aristotelian scheme of causality.

Regarding priority among the four causes, Thomas Aquinas relates it to his distinction between the temporal process of generation and the completeness of being. He writes, ‘But though unachieved potential precedes actual achievement in things that are generated... nevertheless, simply speaking, achieved actuality comes first, for the actual actualizes the potential and the achieved brings the unachieved to achievement.' Accordingly, matter precedes form in the temporal process of generation, but form precedes matter in achievement, since matter is incomplete without form. Likewise, agency precedes goal (or purpose) in the temporal process of generation, but purpose precedes agency in completeness of being, since the agent's activity fulfils itself in the goal. That is to say, matter and agent are prior in the temporal process of generation, while form and goal are prior in regard to achievement (*On the Principles of Nature*; McDermott 1993: 75-76).

For Aristotle each of the four causes could be the proximate cause or the distant cause of a thing. In addition, the causes are seen as conditions that are necessary but not separately sufficient to account for the existence of a thing. In general, therefore, all four causes are required to produce any effect (Ross 1995: 75). Thomas Aquinas comments that three of the causes can coincide, namely form, goal, and agent. For example, when fire produces fire, then fire is the agent (or producer), the form that realises the potentiality, and the goal towards which the agent tends to fulfil its activity. Matter, in contrast, can never coincide with other causes, since it exists potentially whereas other causes exists actually. In other words, matter is unachieved whereas other causes are achieved, and the achieved and unachieved cannot coincide (*On the Principles of Nature*; McDermott 1993: 76-77).

5.2.6 Chance and necessity

In the *Physics* the phenomena of chance and spontaneity are discussed by Aristotle, in so far as they also act as causes of things coming to be. He builds herein on Plato's discussion thereof in the *Laws*, as noted by the Neoplatonist commentator Simplicius (Gerson 2005: 127). Aristotle reasons that in addition to things that always or mostly come to be in the same way, there is a third class of events that occur due to chance and spontaneity (*Physics* II.196b). The causal role of chance and spontaneity is stated as follows: 'It is clear then that chance is an incidental cause in the sphere of those actions for the sake of something which involve purpose. Intelligent reflection, then, and chance are in the same sphere, for purpose implies intelligent reflection'; and further, 'Both are then, as I have said, incidental causes – both chance and spontaneity – in the sphere of things which are capable of coming to pass not necessarily, nor normally, and with reference to such of these as might come to pass *for the sake of something*' (II.197a; italics ours). In addition, 'Both belong to the mode of causation "source of change", for either some natural or some intelligent agent is always the cause; but in this sort of causation the number of possible causes is infinite' (II.198a). Aristotle then displays his teleological proclivity by concluding, 'Spontaneity and chance, therefore, are posterior to intelligence and nature' (II.198a). This reasoning implies that chance events are not anti-teleological in nature, but rather act as incidental causes in the attainment of purpose.

In his commentary on Aristotle's *On Interpretation*, Thomas Aquinas argues that the notion of incidental causes served to rebut the Stoic view of fate as a chain of causes. In terms of the latter, everything that happens has a cause and each cause must produce an effect. Therefore, the Stoics believed, everything happens as it must. Against this causal determinism, as it were, Aristotle reasoned that not everything has a cause, but only what exists in its own right. Moreover, what exists incidentally has no cause, so that Aristotle agrees with Plato (in the *Sophist*) that it should count as not existing (McDermott 1993: 278). The role of chance in natural processes is explained by Aristotle in *On Generation and Corruption*: 'For the things which come-to-be by natural processes all exhibit, in their coming-to-be, a uniformity either absolute or highly regular: while any exceptions – any results which are in accordance neither with the invariable nor with the general rule – are products of chance and luck' (II.333b). That is to say, chance is an additional cause to the standard four, pertaining to events that form exceptions to the habitual rule of nature. However, for Aristotle the reality of chance events does not imply the existence of contingency. Instead, chance is simply a name for the unforeseen meeting of two chains of rigorous causation (Ross 1995: 77-78, 80).

The Aristotelian philosophy of nature accommodates both necessity (*anangke*) and purpose, or end (*telos*). As reasoned in the *Physics*, 'Therefore action for an end is present in things which come to an end and are by nature. Further, where a series has a completion, all the preceding steps are for the sake of that. Now surely as in intelligent action, so in nature; and as in nature, so it is in each action, if nothing interferes. Now intelligent action is for the sake of an end; therefore the nature of things also is so... Each step then of the series is for the sake of the next... If, therefore, artificial products are for the sake of an end, so clearly also are natural products' (II.199a). Aristotle's remarks on the purposefulness of steps in a series of events is clearly relevant to the evolution of life-forms. On the other hand, 'The end and the means towards it may come about by chance... This is incidental, for chance is an incidental cause' (II.199b). However, while admitting the role of chance in nature, Aristotle affirms the prevalence of purpose: 'But when an event takes place always or for the most part, it is not incidental or by chance... It is plain then that nature is a cause, a cause that operates for a purpose' (II.199b). In Aristotle's conception, necessity in nature entails movement to a purpose, and the purpose has been attained when matter has been formed (Dreyer 1975: 135).

Some further remarks on Aristotle's conception of necessity would be appropriate. He distinguishes between absolute necessity which is manifested in eternal phenomena, and hypothetical necessity which is manifested in everything that is generated by nature and everything that is produced by art (*Parts of Animals* I.639b). An important instance of absolute necessity is circular motion, such as that of the sun which ensures the continuity of alternate generation and destruction (*On Generation and Corruption* II.338a). Many other natural phenomena are due to absolute necessity, flowing inevitably from the nature of the particular matter (Ross 1995: 81). The effects of gravity would be a conspicuous example. Thomas Aquinas comments that absolute necessity results from causes prior in the process of generation, namely matter and agency, and is therefore also called material necessity. On the other hand, hypothetical necessity results from causes posterior in the process of generation, namely form and goal (i.e. purpose), and it is therefore also called necessity for a goal (*On the Principles of Nature*; McDermott 1993: 76). An example of hypothetical necessity is animals requiring food in order to live (*Parts of Animals* I.642a). Whereas Aristotle thus views absolute necessity as unrelated to final causality, the hypothetical necessity in nature provides the conditions for an explanation in terms of final causality (Gerson 2005: 122).

Aristotle recognised that there are cases in nature where mechanism alone is at work, without the operation of final causality. This is due to the hypothetical necessity of matter, as stated in the *Physics*: 'What is necessary then exists by hypothesis and not as an end (*telos*); for it exists in matter, while the final cause is in the account (*logos*)' (II, 200a; translation by Gerson 2005: 122). We have earlier noted the metaphysical meaning of *logos* as reason or principle, so that it also indicates formal causality. Aristotle adds in this context, 'There are then two causes, namely, necessity and the final end. For many things are produced, simply as the results of necessity' (*Parts of Animals I.*642a). Accordingly, certain phenomena are to be explained only by material and efficient causes, for example the colour of a person's eyes. Sometimes necessity even opposes teleology, as in the case of monstrous births that are due to defective matter (*Generation of Animals* 778a-b, 767b; Ross 1995: 82).

The phenomenon of physical deformity (for example a crooked leg) is explained by Thomas

Aquinas in terms of Aristotelian causality: 'For if the matter is not disposed to receive the agent's imprint a defect will follow in the effect, as when monsters are born because of unprepared matter: the fact that it doesn't transform and actualize the indisposed matter can't be laid at the door of the agent, for agents have powers proportioned to their natures and their inability to go further can't be called deficiency in power; we can say that only when its power falls short of the measure laid down by nature' (*Summa contra Gentiles,* 3.10; McDermott 1993: 286). By recognising the role of both finality and mechanism in nature, Aristotle to some extent continues Plato's notion that the cosmos is the product of the interaction between the divine Intellect (the Demiurge) and irrational Necessity (*Anangke*).

5.2.7 Movement and change

Since a dynamic view of substance is held by Aristotle (as in the ceaseless interaction between the generation and destruction of substance), movement (or motion, *kinēsis*), is of central importance in his metaphysics. Movement is defined as 'The fulfilment of what exists potentially, in so far as it exists potentially' (*Physics* III.201a). Aristotle enumerates six kinds of movement: generation and destruction (or coming to be and passing away), increase and diminution, alteration, and change of place or locomotion. The opposite of motion, generally speaking, is rest (*Categories* 14 & 15a-b). Moreover, and contrary to the modern academic view of Aristotle as an anti-Platonist, it is affirmed in the *Metaphysics* that the good and the beautiful are the beginning (or cause) both of the knowledge and of the movement of many things (V.1013a). Indeed, Plato could not have stated it better himself.

Movement is conceived by Aristotle as related to *entelecheia*, which means fulfilment or completion. Thus movement is purposeful, representing a transition from potency to actuality (Dreyer 1975: 135). As stated in the *Physics*, 'Hence we can define motion as the fulfilment of the movable as movable, the cause of the attribute being contact with what can move, so that the mover is also acted on' (III.202a). Moreover, the mover imparts form to the moved: 'The mover or agent will always be the vehicle of a form, either a "this" or a "such", which, when it acts, will be the source and cause of the change, e.g. the full-formed man begets man from what is potentially man' (III.202a).

The relation between movement and change (*metabolē*) has been described by Aristotle in ontological terms. Firstly, three kinds of change are distinguished: (i) accidental change; (ii) a thing changes because something belonging to it changes; and (iii) a thing changes in virtue of being itself directly in motion, i.e. it is essentially movable. Therefore, the factors involved in motion are that which directly causes motion, that which is in motion, and that in which motion takes place, namely time. Moreover, every motion proceeds from something and to something – for instance, 'perishing' entails change from being to non-being, whereas 'becoming' entails change from non-being to being (*Physics* V.224a-b). In summary, it could be stated that three types of being are distinguished by Aristotle in terms of movement: that which is moved but doesn't move (i.e. primary matter); that which is moved and moves (i.e. all natural things); and that which causes movement without moving, i.e. God (Dreyer 1975: 136). A kind of kinetic hierarchy is thus established with God at the summit, unformed matter at the bottom, and the world of natural phenomena in between.

5.2.8 Cosmology

All bodies subject to generation consist of elements, Aristotle held. An element (*stoicheion*) is defined as 'a body into which other bodies may be analysed, present in them potentially or in actuality... and not itself divisible into bodies different in form' (*On the Heavens* III.302a). Thomas Aquinas also refers to the definition of an element in the *Metaphysics* (V.1014a), as what things are ultimately made up of, existing in the things, and indivisible in its own nature. For Aristotle an element cannot be broken down or divided into heterogeneous parts. It can, however, be quantitatively divided into homogeneous parts (*On the Principles of Nature*; McDermott 1993: 73-74). Aristotle rejects the notion of an infinite element by arguing that a principle is greater in power than in extent. Therefore, 'that which was small at the start turns out a giant at the end' (*On the Heavens* I.271b). Or, as commented by Aquinas, big mistakes grow from small beginnings (*On Being and Essence*; McDermott 1993: 91).

Opposing the view held by some of the Presocratics that the elements are either one or infinite in number, Aristotle reasoned that the elements have to be several and finite in number. Furthermore, the elements cannot be eternal, but are subject to destruction and generation. And since the elements cannot be generated from something incorporeal or from a body which is not an element, they have to be generated from one another (*On the Heavens* III.302b, 303b, 304b, 305a). Following Empedocles and Plato, Aristotle accepts the four elements of fire, air, water, and earth.[20] However, he prefers referring to them as 'simple bodies' in which the contrary pairs of hot and cold and dry and moist are equally present.

[20] Although it should be kept in mind that Plato preferred the term 'kinds' to 'elements', since the latter are not fundamental but arise from geometrical figures which are ultimately based on numbers.

Thus fire is hot and dry, air is hot and moist, water is cold and moist, and earth is cold and dry (*On Generation and Corruption* II.330b).

Furthermore, another simple (i.e. uncompounded) body with a circular motion exists beyond the four earthly bodies. This element, or body, is eternal, ungenerated, indestructible and unalterable. It is not infinite but limited, since no infinite body exists (*On the Heavens* I.269a-b, 270a, 273a, 274a). This fifth element is called ether (*aithēr*), which is accordingly referred to as the quintessential element. In the traditional cosmology ether is viewed as filling all space without distinction, since a totally empty space (i.e. a void) could not exist. Ether lies at the basis of all material differentiations, and as such 'represents the continuous ground whence all material discontinuities detach themselves' (Burckhardt 1974: 132).

Whereas Plato distinguished between the sensible world of becoming and the intelligible world of being, Aristotle made a distinction between the terrestrial and celestial worlds. As stated in the *Parts of Animals*, 'Of things constituted by nature some are ungenerated, imperishable, and eternal, while others are subject to generation and decay. The former are excellent beyond compare and divine, but less accessible to knowledge' (I.644b). In other words, for Aristotle the terrestrial world is imperfect and mutable, consists of the four elements, and is subject to natural laws, whereas the celestial world is perfect and immutable, consists of ether, and is itself the realm of supernatural laws (Swift 2002: 19). Since only the sub-lunar world is ruled by natural laws, it is for Aristotle the domain of natural science.

The Platonic doctrine that the world is generated yet eternal (since the Demiurge orders pre-existing matter rather than creating it from nothing) is criticised by Aristotle on the grounds that generated things are always observed to be destroyed. In addition, an eternal state is impervious to change. That which always exists is imperishable and ungenerated, Aristotle reasons, since it is incapable of alternating between being and non-being (*On the Heavens* I. 279b-280a). In his work on Indo-European religion the German scholar Hans Günther contended that Aristotle thus re-affirmed the Indo-European cosmology, over and against the notion of creation which is said to be of Oriental provenance, and which Plato had adopted in the *Timaeus* (2013: 11). However, it was suggested by Thomas Aquinas that Aristotle's stance on the eternity of the world is compatible with the doctrine of divine creation in time, since the former entails an attack on a certain position, namely the introduction of an agent (i.e. efficient) cause by Anaxagoras (mind) and Empedocles (love and strife). Against this view

Aristotle argued in Book VIII of the *Physics* that if such a postulated cause established the world through change, then an infinite regress would occur, and he therefore concluded that the world has always existed. In the words of Aquinas, ‘As a result he argued to the eternity of the world from change and the first mover’s lack of change’ (*Quaestiones Disputatae de Potentia*, 3.17; McDermott 1993: 267-268).

Moreover, Aristotle concurs with the statement in the *Timaeus* (30a) that the ordered arose out of the unordered, arguing that since the same thing cannot be simultaneously ordered and unordered, a process and a timespan is required to separate the two states (*On the Heavens* I.281b). Aristotle also appears to agree with Plato on the priority of the eternal (*to aionion*) over the transitory, as is indicated in the *Metaphysics* concerning the priority of the actual over the potential: ‘For eternal things are prior in substance to perishable things, and no eternal thing exists potentially’ (IX.1050b; Gerson 2005: 193). That is to say, the cosmos arose out of chaos through the ordering activity of the Prime Mover.

5.2.9 Generation and destruction

In his work *On Generation and Corruption* Aristotle analyses the phenomena of coming-to-be and passing-away in nature. Regarding the former, ‘For coming-to-be necessarily implies the pre-existence of something which potentially “is”, but actually “is not”; and this something is spoken of both as “being” and as “not-being”’ (I.317b). The cause of something coming-to-be (i.e. the transition from potentiality to actuality) means both the source from which the process originates and the matter involved. In its turn the material cause of coming-to-be is the substratum which changes from contrary to contrary (I.318a, 319a). Aristotle reasons further that for something to come to be out of another thing, an efficient cause is required to provide actuality, or form, to the matter concerned. This efficient cause of something coming-to-be is either an actual thing or an actuality. In its turn the actual thing serving as efficient cause is either generic, for example a freezing wind producing ice, or specific, for example a man begetting a man (I.320b; Joachim 2001: 487).

Thomas Aquinas commented that generation entails movement from non-existence to existence, whereas destruction entails an opposite movement from existence to non-existence. However, ‘generation starts not from any sort of not existing but from a not existing which is potential of existence: statues are made from copper which is potentially a statue though not actually. So three things are needed for generation: something potential of existence – the material of matter, its lack of actualization – a lacking of being, and something to give it actualization – a form' (*On the Principles of Nature*; McDermott 1993: 68-69). Moreover, for Aristotle generation and destruction are not mutually exclusive forces with regards to substance. Since the substratum is the material cause of things ceaselessly coming to be, 'in substances, the coming-to-be of one thing is always a passing-away of another, and the passing-away of one thing is always another's coming-to-be' (*On Generation and Corruption* I.319a). Therefore, Ross remarks, 'Generation and destruction are the two sides of a single transformation of substance into substance' (1995: 101).

Aristotle also applied his four-fold scheme of causality to the generation and destruction of substance. Thus the material cause is 'that which can-be-and-not-be', in other words that which makes coming-to-be and passing-away possible; and the simultaneous formal and final cause is 'the formula expressing the essential nature' of things. However, Aristotle rejects the Platonic notion of the Forms as efficient cause of coming-to-be and passing-away (as depicted in the *Phaedo*), on the grounds that their generating activity is intermittent, whereas things are said to participate perpetually in the Forms (*On Generation and Corruption* II.335a-b). Instead, Aristotle suggests that the efficient cause of coming-to-be and passing-away is the movement of the sun towards and away from the earth: 'Thus we see that coming-to-be occurs as the sun approaches and decay as it retreats; and we see that the two processes occupy equal times' (II.336b). In other words, the generation and destruction of substance is caused by the annual movement of the sun in the ecliptic or zodiac cycle (Cornford 1997: 11).

However, although Aristotle attributed efficient causality to solar cycles and not to the Forms, he recognised the paradigmatic causality of the latter in the generation of substance. For instance, in the *Metaphysics* it is argued that neither the form nor the substance of a sensible thing is produced, but the concrete thing which consists of matter and form. Also, since substances in the sense of concrete things are capable of generation they are also capable of destruction, but substances in the sense of general formulae are incapable of generation or destruction. It is therefore not the essence (*ousia*) of house that is generated, but the essence of this particular house (VII.1033b, 1034b, 1039b). Aristotle concludes his reasoning as follows: 'But it has been proved and explained elsewhere that no one makes or begets the form, but it is the individual that is made, i.e. the complex of form and matter that is generated' (*Metaphysics* VIII.1043b). A distinction is thus made between the essential Form and the en-mattered form, with the latter participating in the former (Gerson 2005: 121).

5.3 The Prime Mover and Theology

Due to the fact that motion is continuous, Aristotle argues, there has to be an ultimate first cause of all motion in the cosmos. As stated in the *Physics*, 'Since there must always be motion without intermission, there must necessarily be something, one thing or it may be a plurality, that first imparts motion, and this first movent must be unmoved' (VIII.258b). After reasoning further that the unmoved mover has to be one and eternal, Aristotle declares that the cosmos (which is first moved by the unmoved mover) likewise has to be eternal (VIII.259a-260a). Aristotle consequently distances himself from Plato, who is said to have viewed the cosmos as having a beginning in time and time itself as being created (VIII.251b). However, according to Proclus, Aristotle is mistaken with this reading of Plato, whose creation account in the *Timaeus* is mythical and not literal; that is to say, the generation of the world is not temporal (Gerson 2005: 129). We have also noted the argument by Thomas Aquinas that Aristotle's stance on the eternity of the world does not preclude its creation in time.

Among Aristotle's extant writings Book XII of the *Metaphysics* contains the clearest exposition of his theology, which is conceived as a science of being *qua* being (Gerson 2005: 188). In this treatise the Prime Mover is defined as the first principle of movement whose essence is actuality (XII.1071b). Aristotle had in an earlier book of the *Metaphysics* argued that since actuality is prior in substantial being to potency, 'one actuality always precedes another in time right back to the actuality of the eternal prime mover' (IX.1050b). The nature of the Prime Mover is further outlined as follows: 'And life (*zōē*) also belongs to God; for the actuality of thought is life, and God is that actuality; and God's self-dependent actuality is life most good and eternal. We say therefore that God is a living being, eternal, most good, so that life and duration continuous and eternal belong to God; for this *is* God' (XII.1072b). Also, since the Prime Mover is a substance which is eternal and unmovable (*Metaphysics* XII.1071b), it has to be incorporeal (*aneu hylēs*) (Gerson 2005: 189). The Unmoved Mover of Aristotle is thus the equivalent of the Supreme Principle (Sanskrit *Atma*), which is not itself involved in its productions, but instead brings forth the world through its poles of Essence and Substance (Perry 1991: 23).

Aristotle also provided an ontological dimension to the role of God as Prime Mover. In *On Generation and Corruption* he argues as follows: 'Now "being"... is better than "not-being": but not all things can possess being, since they are too far removed from the "originative source”. God therefore adopted the remaining alternative, and fulfilled the perfection of the universe by making coming-to-be uninterrupted: for the greatest possible coherence would thus be secured to existence, because that “coming-to-be should itself come-to-be perpetually” is the closest approximation to eternal being’ (II.336b). Furthermore, in the *Metaphysics* Aristotle affirms the divine activity as thinking: ‘Therefore it must be of itself that the divine thought thinks (since it is the most excellent of things), and its thinking is a thinking on thinking (*he noēsis noēseōs noēsis*)’ (XII.1074b). Aristotle’s argument proceeds as follows: since God is thinking what is best, and God is best, it follows that God is thinking himself (Gerson 2005: 197). It appears that God is conceived by Aristotle as the locus of all that is intelligible, much like Plato’s Demiurge in the *Timaeus*. In this way Aristotle implicitly acknowledges the paradigmatic causality of the Forms, ‘For what the prime unmoved mover thinks is ontologically prior to forms in matter’ (Gerson 2005: 200).

Since God is equated with perfection, Aristotle views the universe as good. In contrast, evil is the failure of realisation – it represents possibility not actualised, matter not formed, and purpose not attained (Dreyer 1975: 133). Against the dualistic cosmology that would later be popularised by the Gnostics, Aristotle denies the existence of an evil principle in the world, since if that which is eternal can have no element of potentiality, it cannot have an element of evil either. Evil is therefore not a necessary feature of the universe but a by-product of the world-process, so that there is no evil apart from particular things (Ross 1995: 184).

The identity of the Prime Mover with final causality is affirmed in the *Metaphysics*: ‘The final cause, then, produces motion as being loved, but all other things move by being moved. Now if something is moved it is capable of being otherwise than it is... But since there is something which moves while itself unmoved, existing actually, this can in no way be otherwise than as it is... The first mover, then, exists of necessity; and in so far as it exists by necessity, its mode of being is good, and it is in this sense a first principle (*archē*)... On such a principle, then, depend the heavens and the whole of nature’ (XII.1072b). Thus Aristotle recognises the dependence of the cosmos on an extraneous first principle, the Prime Mover.

5.4 Philosophy of nature, or bio-philosophy

Aristotle is widely regarded as the father of biological studies in the Western world. This recognition dates back to the classical Hellenic era, with its saying that ‘Aristotle was nature’s scribe, his pen dipped in mind (*nous*)’ (quoted in O’Rourke 2004: 3). His biological observations and metaphysical insights constantly interacted, leading to mutual reinforcement for his metaphysics and biology (O'Rourke 2004: 4, 26). Also, Aristotle did not view biology and psychology as separate sciences, but rather as a single science of life. He wrote several works pertaining to this group, including *The History of Animals* recording facts about hundreds of animal species, *On the Parts of Animals* dealing with their material qualities, *On the Soul* dealing with their essential form, and *On the Generation of Animals* dealing with their procreation (Ross 1995: 117). Believing in the supremacy of observation, Aristotle argued that scientific theories should conform to observed facts, and not the other way round (*Generation of Animals* 760b; Ross 1995: 126). He thus pioneered the empirical method employed by the modern natural sciences, although the materialist reductionism of the latter would have been rejected by Aristotle due to his metaphysical grounding.

The importance of the study of animals is eloquently presented by Aristotle in the *Parts of Animals*: 'For if some [i.e. animal species] have no graces to charm the sense, yet even these, by disclosing to intellectual perception the artistic spirit that designed them, give immense pleasure to all who can trace links of causation, and are inclined to philosophy... Every realm of nature is marvellous... so we should venture on the study of every kind of animal without distaste; for each and all will reveal to us something natural and something beautiful' (I.645a). This affirms that Aristotle's biological work is firmly grounded in teleology.

5.4.1 Form

In contrast to the materialistic bias that has come to dominate the scientific world since the seventeenth century, Aristotle insisted that the nature of things is more properly found in their form (*eidos* or *morphē*) than in their matter (*hylē*). As argued in the *Parts of Animals*, 'For the formal nature is of greater importance than the material nature' (I.640b). This implies that the essence of animals and their parts is not to be found in their configuration or colour, as Democritus had said concerning humans. Against this misconception Aristotle argues that a dead body has the same configuration as a living one, but he is decidedly not a man (*Parts of Animals* I.640b). Discussing the relation between body and form, Thomas Aquinas concludes that 'body is anything of a form such that it can occupy three dimensions, whatever form that may be.' The form of an animal is thus implicit in the form of body, with body being its genus (*On Being and Essence*; McDermott 1993: 95-96).

The Aristotelian insistence on the priority of the formal over the material is related to his metaphysics of potency and actuality. As reasoned in the *Physics*, ‘The form indeed is “nature” rather than the matter; for a thing is more properly said to be what it is when it has attained to fulfilment than when it exists potentially’ (II.193b). In other words, a thing has its nature more fully when it exists actually (i.e. has attained its form) than when it exists potentially (i.e. the mere matter for it exists). David Ross concludes, ‘The form of structure of a thing – e.g. an animal – is just that by virtue of which it moves, grows, and alters, and comes to rest when it has reached the terminus of its movement. And conversely the power to move, grow, and alter in a certain definite way is just the form or character of each thing’ (1995: 71).

5.4.2 Reproduction

For Aristotle reproduction is the most fundamental phenomenon of life, even more so than movement and sensation, since it is the only bio-phenomenon that can occur without the others, as is the case among plants (Ross 1995: 122). As argued in the *History of Animals*, ‘Thus of plants that spring from seed the one function seems to be the reproduction of their own particular species, and the sphere of action with certain animals is similarly limited. The faculty of reproduction, then, is common to all alike’ (VIII.588b). Aristotle provides an ontological and psychological grounding for the striving of all living beings to reproduce their type faithfully: ‘And since soul is better than body and the ensouled is better than the soulless owing to its soul and being (*to einai*) is better than not being (*me einai*) and living (*to zen*) better than not living (*me zen*), for these reasons reproduction (*genesis*) of living things exists... Since it is impossible for it [i.e. a living thing] to be eternal as an individual..., it is possible for it to be eternal in species. This is the reason why there exists eternally the class of human beings, animals, and plants’ (*Generation of Animals* I.731b-732a; quoted in Gerson 2005: 118). Thus, because individuals are unable to live eternally, reproduction serves to preserve the class (*genos*) and species (*eidos*) of organisms (O’Rourke 2004: 46). Accordingly, ‘Existence is joined to eternity not only through the qualities manifested in it, but also through its rhythms, which as it were compensate the irreversible and devouring character of time’ (Northbourne 1995: 105).

Aristotle also relates the form and matter interaction to sexual differentiation: while the female is the principle of matter, the male is the principle of form (Dreyer 1975: 140). In other words, the male parent impresses a certain form on the matter supplied by the female parent. The male semen thus acts as formal cause of the offspring, while the female menstrual discharge acts as material cause (*Generation of Animals* I.729a-730b; Ross 1995: 123-124).

Aristotle held further that animals copulate to attain a union of the male and female principles, which in plants are permanently mixed. In this sense, animals are like divided plants. However, animals exist not only for generation (as do plants) but also to participate in a kind of knowledge through sense-perception (*Generation of Animals* I.731a).

As far as the development of animals is concerned, Aristotle rejects the Hippocratic theory of pangenesis, according to which the embryo contains all its parts fully preformed in miniature (a detailed criticism is found in *Generation of Animals*, Book I). Instead, Aristotle argued that the parts of the young animal do not exist preformed, but are produced gradually and successively. Stated in terms of Aristotle's metaphysics: 'The parts of the animal are formed successively, with the gradual actualization of what is initially present in potency, under the agency of what is actual' (O'Rourke 2004: 9-10). Aristotle thus laid the conceptual foundation for the empirically verified theory of epigenesis, in terms of which 'embryonic development is a chain of new constructions, each perfecting the preceding, with the final differentiation of the living individual emerging at the end' (O'Rourke 2004: 10). In this way the science of embryology, according to which the processes of growth serve to build up the body of the future animal, has to a certain extent preserved teleology (Thompson 1992: 4).

The phenomenon of heredity was naturally explored by Aristotle, recognising that heredity is related to the sexual act: 'In animals where generation goes by heredity, wherever there is duality of sex generation is due to copulation' (*History of Animals* V.539a). Moreover, 'For man is generated from man; and thus it is the possession of certain characters by the parent that determines the development of like characters in the child' (*Parts of Animals* I.640a). In this way hereditary traits are explained on the grounds of the male parent prevailing over the female, or vice versa. If the impulses imparted by the parents are confused together, then the offspring will be unlike the parents, but they will yet preserve the character of the species (Ross 1995: 127). Remarkably, Aristotle's thoughts on heredity anticipated molecular biology and genetics. According to Wolfgang Kullmann, 'Aristotle's genetics... has an extraordinary similarity with the modern theories in molecular biology of DNA and the genetic code. Aristotle's position... is more balanced than the picture of embryology and genetics in the first half of the twentieth century' (cited in O'Rourke 2004: 11-12).

It is significant that Aristotle does not view the growth of organisms as undirected – to the contrary, every growth has a purpose (*telos*) towards which it proceeds (O'Rourke 2004: 36).

Thus in *Parts of Animals* it is stated, ‘Again, whenever there is plainly some final end, to which a motion tends should nothing stand in the way, we always say that such final end is the aim or purpose of the motion’ (I.641b). Elsewhere Aristotle reasons that the development of living beings is preceded by their essence: ‘The ordered and definite works of nature do not possess their character because they developed in a certain way. Rather they develop in a certain way because they *are* that kind of thing, for development depends on the essence and occurs for its sake. Essence does not depend on development’ (*Generation of Animals* 778b; quoted in O’Rourke 2004: 41). In summary, the growth and development of organic matter is derived from both formal and final causality.

5.4.3 Soul

Aristotle argued that for a variety of reasons soul could not be the origin of movement in the sensible world, and that his predecessors failed to specify the bodily conditions for being moved by soul (*On the Soul* I.403b, 404b, 406a-407b). Soul is defined by Aristotle as ‘the first grade of actuality of a natural body having life potentially in it. The body so described is a body which is organized’ (*On the Soul* II.412a). An alternative translation of this definition is provided by Lloyd Gerson (2005: 133): ‘[soul is] the primary actuality (*entelecheia*) of a natural body with organs (*sōmatos physikou organikou*)’. Aristotle reasons further that the relation of soul to body is that of actuality to potentiality, and of form to matter. And since substance consists of both form and matter, a particular soul is inseparable from its body; in other words, the soul is an actuality of a certain kind of body (*On the Soul* II.413a).

The powers of the soul are described by Aristotle as nutritive, appetitive, sensory, locomotive, and cognitive. Plants have nutritive power, while animals have that as well as appetitive, sensory, and locomotive powers. Humans have all these powers as well as the power of thinking, i.e. mind (*On the Soul* II.414a-b). As interpreted by Thomas Aquinas, there are three levels among the powers of soul: those of vegetable life, of animal life, and of rational life. Functioning at the lowest level, the vegetative powers are generation, growth, and nutrition. The next level, that of sense-awareness, comprises the external senses, general root sensitivity (*sensus communis*), imagination, judgement, and memory. Finally, the highest level, that of intellectual powers, requires agent intellect and receptive intellect. These three levels of the soul’s powers, Aquinas adds, comprise five sorts of ability: nutritive, sensitive, intellectual, appetitive, and locomotive (*Quaestio Disputata de Anima*, 13; McDermott 1993: 132-135).

Since the nutritive faculty is the most widely distributed power of soul, Aristotle contends, it exists in all living beings from birth until death. It manifests itself in the use of food and in reproduction (*On the Soul* II.415a, III.434a). For all living things whose mode of generation is not spontaneous, 'the most natural act is the production of another like itself, an animal producing an animal, a plant a plant, in order that, as far as its nature allows, it may partake in the eternal and divine' (*On the Soul* I.415a-b). This notion of participation in the divine implies that the ultimate aim of nutrition and reproduction is the preservation not of individual life but of the species (Ross 1995: 141). Plato similarly asserted that the mortal nature of both humans and animals strives towards immortality by means of reproduction, which is the only means possible for it (*Symposium* 207c-d; Gerson 2005: 118).

Aristotle reasons further that nutrition and reproduction are due to the same power of soul. Accordingly, what is fed is the 'besouled body' (*empsychon soma*), and thus food is essentially related to what has soul in it. Stated the other way round, if the nutritive soul is deprived of food, it ceases to be (*On the Soul* II.416a-b). Since nutrition and reproduction are psychically linked, the life of animals concentrate on these two activities. Aristotle adds, 'And whatsoever is in conformity with nature is pleasant, and all animals pursue pleasure in keeping with their nature' (*History of Animals* VIII.589a). Interestingly, the mutual friendship or enmity between various animal species is attributed to the food they feed on and the life they lead (*History of Animals* IX.610a).

The next level of soul is the sensitive, which occurs in all animals but not in plants. Each of the five senses, Aristotle asserts, has the power of receiving into itself the sensible forms of things without the matter. Of these powers, touch is indispensable to all animals, since its loss would bring about the death of the organism. The remaining senses serve well-being rather than mere survival, since sight enables an animal to see through air or water, taste enables it to distinguish painful or pleasant qualities in its nutrition, and hearing enables communication with its fellows (*On the Soul* II.424a, III.434b, 435b). Aristotle adds that in the case of humans sight and hearing also pertains to the life of thought, in that the hearing of speech is the main instrument of teaching and learning, while sight reveals differences in colour, number, size, shape and movement (*Metaphysics* I.980a-b).

Aristotle declared that soul is in a way all existing things, for existing things are either sensible or thinkable (a distinction similar to that of Plato). Within the soul the faculties of knowledge and sensation are *potentially* the objects of knowledge or sensation. Moreover, since it is impossible for sensible things to be present in the soul, it is the mind which senses the form of sensible things. Mind is also related to appetite, since both are sources of local movement: while mind calculates means to an end, appetite is relative to an end (*On the Soul* III.431b-432a, 433a). Nevertheless, for Aristotle the rational function differs from the other powers of soul, since ‘mind must be related to what is thinkable, as sense is to what is sensible.’ Thus, ‘the thinking part of the soul must therefore be, while impassible, capable of receiving the form an object.’ It is therefore correct to view the soul as ‘the place of forms’, with the qualifications that this pertains only to the ‘intellective soul’ and to the forms as potentiality and not as actuality (*On the Soul* III.429a). With this relation of the rational soul to the Forms, Aristotle treats *to noēton* and *to eidos* as synonymous (Gerson 2005: 209).

Against the modern reductionist fantasy that mind is a product of the brain, Aristotle argued that mind cannot reasonably be viewed as blended with the body, since it cannot acquire a quality such as hot or cold, or an organ of sense-perception. Accordingly, ‘that in the soul which is called mind (whereby the soul thinks and judges) is, before it thinks, not actually any real [i.e. material] thing’ (*On the Soul* III.429a). Evidently, in the Aristotelian conception reason has no connection with matter and enters it from the outside, being divine in nature (*Generation of Animals* 736b). Although he preferred a clear distinction between reason and the other faculties of soul, at times Aristotle seemed to maintain the continuity of reason with sensation (Ross 1995: 125). This continuity pertains especially to memory. For instance, in the *Posterior Analytics* it is argued that memory arises out of sense-perception, and out of frequently repeated memories develops experience (II.100a); and in the *Metaphysics* it is written, ‘By nature animals are born with the faculty of sensation, and from sensation memory is produced in some of them, though not in others. And therefore the former are more intelligent and apt at learning than those which cannot remember’ (I.980a-b).

Further displaying his allegiance to the Indo-European tradition, Aristotle made a distinction between soul (*psychē*) and spirit, or mind (*nous*), cohering with the distinction between sense perception (*aisthēsis*, the activity of soul) and contemplative thought (*noēsis*, the activity of spirit, or mind). This distinction would be taken over by Plotinus and become normative in the Neoplatonic tradition (Oosthuizen 1974:101). Among some recent commentators confusion arose due to their conflation of mind, or intellect (*nous*), with reason (*dianoia*). However, Aristotle consistently employs the terms mind, or intellect (*nous*), instead of reason (*dianoia*), in the relevant passages of *On the Soul*. For example, at II.415a and III.433a reference is made to theoretical intellect (*theōrētikos nous*) and practical intellect (*praktikos nous*), in the same way as Aristotle elsewhere mentions the different functions of the soul, such as nutritive (*threptikē*), generative (*gennētikē*), and discursive (*dianoētikē*). Since this distinction between functions of the soul does not imply the existence of multiple souls in the human being, it would be more correct to speak of a distinction between active and passive principles in the intellect, rather than the presence of two intellects (Gerson 2005: 156).

It is affirmed by Aristotle that the soul is the cause of the body in three senses: (a) the source or origin of movement, whether it be locomotion or alteration; (b) the end or final cause; and (c) the essence of the whole living body (*On the Soul* II.415b). In other words, the soul is the form of a living being, guiding the latter towards its purpose. Each living thing therefore has a natural purposefulness (Dreyer 1975: 139). In the concrete unity of matter and form that constitutes a living body (*empsychon soma*, literally 'besouled body'), body plays the part of matter or possessor of attributes, while soul plays the part of form or essential attribute. Since for Aristotle soul is the first actuality of a living thing, its exercise of functions is the second actuality derived from the first (Ross 1995: 140).

Aristotle affirms the priority of soul as follows: 'Further, since it is the soul by or with which primarily we live, perceive, and think: – it follows that the soul must be a ratio or formulable essence, not a matter or subject' (*On the Soul* II.414a). Accordingly, it is the presence of soul that distinguishes the living from the non-living and the thinking from the non-thinking. Moreover, although all living beings possess soul, the faculty of mind (*nous*) is found only among humans. For Aristotle it is this intellectual faculty that distinguishes humans from all other earthly beings (Dreyer 1975: 140). With admirable modesty Aristotle admits that the questions of when, how, and whence regarding the acquisition of mind by humans is a most difficult one (*Generation of Animals* 736b; O'Rourke 2004: 31).

Among the medieval Schoolmen Aristotle's thought on the relation between the soul and the body would be viewed as analogous to the relation between the unity of the cosmos and the multiplicity of beings. Thus Thomas Aquinas evoked Aristotle's reasoning that the soul provides a unity (or form) to the material body with its many organs. Therefore, a body with a larger variety of organs requires a more perfect soul to grant unity or form thereto. That is to say, for Aquinas the ontological whole is more perfect when it is characterised by a greater complexity of beings (Goosen 2007: 153). This argument implies that the reality of the many is not at all denied by the recognition of the One that underlies it, just as little as the reality of the body is denied by the priority of the soul that gives form to it.

5.4.4 Scale of nature

Probably spurred by his wide-ranging biological interests, Aristotle became the first Western thinker to attempt a classification of animal species. He recognised three grades of likeness within the animal kingdom: identity of type among individuals within a species; likeness among species of the same genus; and likeness among 'greater genera' – for instance, the homology between arm, fore-leg, wing, and fin among various vertebrate classes (Ross 1995: 118-119). The guiding principle for animal classification is stated in *Parts of Animals*: 'Groups that only differ in degree, and in the more or less of an identical element that they possess, are aggregated under a single class; groups whose attributes are not identical but analogous are separated' (I.644a). Whereas a species (e.g. human) is characterised by all its individual members possessing common attributes, a larger group (e.g. birds or fishes) is determined by a similarity in the shape of particular organs or of the whole body (I.644a-b). Aristotle thus anticipated the taxonomical work of Carl Linnaeus by more than two millennia.

Animals were arranged by Aristotle in a hierarchy according to the degree of development reached by the offspring at their time of birth (*Generation of Animals* II.732a-733b). This degree of development was ascribed to the degree of vital warmth possessed by the parent animals. In terms of this approach the highest types of animals are the viviparous ones, among which the offspring are smaller versions of the parents. The next types are egg-laying: first those types producing a 'perfect' egg, i.e. the egg does not grow in size after being laid; then the types producing an 'imperfect' egg, which has to grow. The whole scale of nature appears as follows, in descending order: humans, land mammals, sea mammals, birds, reptiles and amphibians, fishes, cephalopods, crustaceans, insects, molluscs other than cephalopods, and finally zoophytes (Ross 1995: 120-122).

As a keen observer of nature Aristotle recognised the existence of intermediate life-forms. In the *History of Animals* he depicts the continuity between plants and animals, and between the inanimate and the animate: 'Nature proceeds little by little from things lifeless to animal life in such a way that it is impossible to determine the exact line of demarcation, nor on which side thereof an intermediate form should lie. Thus, next after lifeless things in the upward scale comes the plant, and of plants one will differ from another as to its amount of apparent vitality; and, in a word, the whole genus of plants, whilst it is devoid of life as compared with an animal, is endowed with life as compared with other corporeal entities. Indeed, as we just remarked, there is observed in plants a continuous scale of ascent towards the animal. So, in the sea, there are certain objects concerning which one would be at a loss to determine whether they be animal or vegetable' (VIII.588b). This is affirmed in the *Parts of Animals*: 'Nature passes in a continuous gradation from lifeless things to animals, and on the way there are living things which are not actually animals, with the result that one class is so close to the next that the difference seems infinitesimal' (681a; quoted in O'Rourke 2004: 39).

The morphological affinity between humans and primates was also recognised by Aristotle. In both *History of Animals* and *Parts of Animals* he declares apes, monkeys, and baboons to be intermediate (in nature, *tēn physin*, and in form, *dia tēn morphēn*) between humans and quadrupeds, and could be grouped with either or neither (O'Rourke 2004: 40). Indeed, anyone who has observed the behaviour of especially the anthropod apes, has to be struck by its parallels with human behavioural patterns such as affection, curiosity, and cruelty.

Ultimately, Aristotle saw the world of living beings as integrally connected. In the *Metaphysics* he declares, 'And all things are ordered together somehow, but not all alike – both fishes and fowl and plants; and the world is not such that one thing has nothing to do with another, but they are all connected. For all are ordered together to one end... that all must at least come to be dissolved into their elements, and there other functions similarly in which all share for the good of the whole' (XII.1075a). This reference to living things ending in the dissolution of their elements indicates their purpose, namely the production of higher forms of being by new combinations of the elements (Ross 2001: 886). The interconnectedness of all living things is therefore grounded in teleology, being ordered for a specific end or purpose.

5.5 Teleology

As an introductory remark it should be noted that Aristotle does not use the terms final cause or finalism as such, but rather the 'end' (*telos*, also 'purpose'), the 'in view of which' (*to hou heneka*), and the 'why' (*dia ti*) of things (Gilson 2009: 5). As stated repeatedly in *On the Soul*, 'For Nature, like mind, always does whatever it does for the sake of something, which something is its end' (II.415b); 'Nature never makes anything without a purpose and never leaves out what is necessary, except in the case of mutilated or imperfect growths' (III.432b);

and ‘For all things that exist by Nature are means to an end, or will be concomitants of means to an end’ (III.434a). This notion of natural purposefulness is affirmed in the *Parts of Animals*: ‘Everything that Nature makes is means to an end’ (I.641b). Aristotle averred that his predecessors failed to see the teleology in nature because they focused on material principles and causes. In addition, it is claimed that they did not possess the notion of essence or any definition of substance (*Parts of Animals* I.640b, I.642a). However, Heraclitus with his Logos and Anaxagoras with his Nous, to name but two conspicuous examples, could not be charged with materialistic reduction of causality.

A distinction is made by Aristotle between two meanings of final cause, namely the result for the sake of which and the person or thing for whom or for which something is done (Gerson 2005: 123). Thus the phrase ‘for the sake of which’ means ‘either the end to achieve which, or the being in whose interest, the act is done’ (*On the Soul* II.415b). This distinction is repeated in the *Metaphysics*, where Aristotle proceeds to add that the final cause produces motion as being loved, but all other things by being moved (VII.1072b). Moreover, the *Nicomachean Ethics* opens with the following teleological statement: ‘Every art and every inquiry, and similarly every action and pursuit, is thought to aim at some good; and for this reason the good has rightly been declared to be that at which all things aim’ (I.1094a). In the light of passages such as these, Simplicius affirmed that for Aristotle the ultimate final cause is God, the Prime Mover (Gerson 2005: 126).

Aristotle strove to demonstrate teleology in nature as a counter to Empedocles’ notion of natural selection by means of ‘survival of the fittest’, which refers to those combinations of limbs or organs that are best adapted for survival (Ross 1995: 80). In the *Parts of Animals*, Aristotle wrote that ‘Nature behaves as if it foresaw the future’ (686a; quoted in Ross 1995: 81). In other words, everything in the natural world is ordered to assure its progress towards the best possible state. It has been asserted by David Ross that the Aristotelian teleology is of an immanent type, according to which the end of each species is viewed as internal to the species. In terms thereof nature is not conceived as a conscious agent, but as a vital force present in all living things (Ross 1995: 129-130). This notion has been related by Etienne Gilson to the principle of least action, as formulated by the French mathematician Maupertuis. An implication of this mathematical principle is that the laws of nature are regulated by an unconscious intention of economy and simplicity of means – reflecting Aristotle’s dictum that ‘Nature does nothing in vain’ (*On the Soul* III.434a; Gilson 2009: 157-158).

However, in the *Metaphysics* a transcendent dimension in nature is implied when Aristotle employs the analogy of an army and its leader. Just as is the case with the nature of the cosmos, the good of an army is found in both its order and its leader; although more in the latter, since the leader does not depend on the order but it depends on him (XII.1075a). And elsewhere Aristotle explicitly declares participation in the 'eternal and divine' as the ultimate goal towards which all things strive (*On the Soul* II.415b). The reason why nature cannot be self-explanatory as productive cause is that it is a moved mover, and not an unmoved mover as is the Intellect (Gerson 2005: 124-125). As affirmed by Aristotle, 'God and nature create nothing that has not its use' (*On the Heavens* I.271a). A transcendent Principle is therefore required as explanation of the teleology in nature.

Aristotle's teleology enables him to indemnify the Prime Mover from the imperfections in nature. Thus imperfections in the structure of animals are ascribed to defective material, not a defective maker. This phenomenon is due to the fact that matter is sometimes not suitable for the purpose in hand, Aristotle suggested. In their turn, imperfections in individual organisms are due to the inherent variability of matter, since the latter is formed of an endless variety of combinations of the four elements (Ross 1995: 130). Nevertheless, finalism cannot be ignored: 'Both causes must be stated by the physicist, but especially the end; for that is the cause of the matter, not vice versa' (*Physics* II.200a).

It should be noted that Aristotle's teleology is integrally linked to his metaphysics of causality. For instance, his notion of causality enabled him to distinguish between characteristics on the species level and on the individual level. Qualities that characterise the whole of a species are to be explained by final and formal causes, while variable characteristics are to be explained by material or efficient causes. For example, in the *Generation of Animals* it is suggested that the formation of a person's eye serves a certain purpose in accordance with the reason (*logos*) of the individual, while the colour of the eye is incidental and must of necessity (*ex anangkes*) be ascribed to its matter and moving cause (778a-b; O'Rourke 2004: 42). That is to say, spontaneous variations among individual organisms should be explained by mechanical (i.e. material and efficient) causes rather than final causes (Ross 1995: 127).

Final causality also pertains to Aristotle's differentiation between homogeneity and heterogeneity in the body parts of animals (Gilson 2009: 4). Its metaphysical basis has been stated by Thomas Aquinas, namely that different forms require different materials to match them. Accordingly, some forms need homogeneous material while others need heterogeneous material, which entails different organisation of the matter fitted to their species of form and its activity (*Summa contra Gentiles*, 3.97-98; McDermott 1993: 272). Aristotle reasons that there are three degrees of composition of body parts: (i) primary substances are composed out of the elementary forces of earth, air, water, and fire; (ii) homogeneous parts, such as bone and flesh, are composed out of the primary substances; (iii) heterogeneous parts, such as face and hands, are composed out of homogeneous parts. Therefore the homogeneous parts exist for the sake of the heterogeneous parts; in other words, their relations are determined by a final cause (*Parts of Animals* II.646a-b). As a matter of fact, all the living operations of animals and plants require differentiation of parts that are capable of interacting, Etienne Gilson has pointed out. Heterogeneous parts require a certain organisation, which is why living bodies are called organisms or that living matter is organic. For Aristotle, mechanical explanations in terms of material and efficient causality explain homogeneous parts satisfactorily, but organisms with heterogeneous structures require a more complex explanation. The latter is provided in terms of final causality (Gilson 2009: 4-7).

For Aristotle the teleology of nature is considerably more perfect than the teleology of art. Whereas the artist gropes around, nature (although limited by matter) generally attains her end without hesitation (Gilson 2009: 12). Accordingly, Aristotle conceives of the artist as a particular case of nature, which is why art imitates nature (*Physics* II.194a) and not vice versa. In the Aristotelian conception there is more design (*to hou heneka*), more good (*to eu*), and more beauty (*to kalon*) in the works of nature than in those of art (Gilson 2009: 12-13). As stated in the *Generation of Animals*, ‘In all this Nature acts like an intelligent workman’ (I.731a). While art has its cause in the human intelligence, the teleology in nature is a mystery to us, but for Aristotle its existence cannot be denied (Gilson 2009: 13). The activity of nature directed towards order and beauty is repeatedly affirmed by Aristotle: ‘But that which is produced or directed by nature can never be anything disorderly: for nature is everywhere the cause of order’ (*Physics* VIII.252a); ‘Nature always strives after the better’ (*On Generation and Corruption* II.336b); and ‘Nature ever seeks amend’ (*Generation of Animals* I.715b).

Although the role of mechanism is acknowledged by Aristotle, the final cause is primary in all living things. He writes in *Parts of Animals*: ‘Plainly, however, that cause is the first which we call the final one. For this is the Reason, and the Reason forms the starting-point, alike in the works of art and in works of nature... Now in the works of nature the good end and the final cause is still more dominant than in works of art such as these, nor is necessity a factor with the same significance in them all' (I.639b). Given the primacy of final causality, Aristotle employed the analogy of a physician or a builder when discussing causality in nature. Thus the proper order of enquiry is not to start with the process of formation of each animal, but to consider first its actual characteristics and then deal with their evolution (Ross 1995: 128). As declared in the *Parts of Animals*, 'For the process of evolution is for the sake of the thing finally evolved, and not this for the sake of the process' (I.640a). Material causality is thus subordinated to final causality. Thomas Aquinas concludes that the goal (i.e. the purpose) is called the cause of causes, since it causes the causality of all the other causes (*On the Principles of Nature*; McDermott 1993: 75). The presence of the final cause is therefore a necessary condition for the actualising of the potential into a particular result.

It has been suggested that Aristotle's teleology should rather be viewed as teleonomy, i.e. finality in nature without suggesting extraneous, conscious design. According to Wolfgang Kullmann, *telos* did not have the sense of plan or purpose for Aristotle, but rather goal and perfection (O'Rourke 2004: 20, 22). A related distinction was made by Ernst Mayr between teleology (i.e. the inner tendency of nature towards cosmic perfection) on the one hand and teleomatic and teleonomic processes on the other. Teleomatic processes are those determined by natural properties, for example the downward flow and eventual emptying of a river in the sea. In contrast, a teleonomic prosess is inherently determined, or programmed, towards a goal. Examples thereof include organic growth, feeding, and reproduction. Michael Tkacz applies Mayr's distinction to that made by Aristotle (*Physics* II.196b) between that which occurs in nature 'by necessity' (*ex anangke*) and that which is 'for the sake of something' (*to hou heneka*) – indicating the teleomatic and the teleonomic, respectively (2013: 672-673).

The reluctance among modern biologists to recognise final causality in nature has been aptly satirised by the British polymath J.B.S. Haldane: 'Teleology is like a mistress to the biologist: he cannot live without her, but he's unwilling to be seen with her in public' (quoted in O'Rourke 2004: 20). Judging by the conceptual hair-splitting between teleology and the so-called teleomatic/teleonomic as mentioned in the previous paragraph, it is clear that the 'ghost of teleology' continues to haunt those unwilling to admit a transcendent influence in the processes of life, even if such influence acts indirectly through the Intellect/Logos rather than directly from the Principle into the realm of Manifestation.

5.6 Conclusion

More than any of his Hellenic predecessors, Aristotle took the study of the physical world in its multifarious facets seriously. He is therefore rightly honoured as the father of Western natural science, just as Plato is justly honoured as the father of Western religious philosophy. In addition, Aristotle laid the conceptual foundations for the study of logic and metaphysics in the Western world. However, during the twentieth century it become fashionable in certain academic circles to view Aristotle's metaphysics as being incompatible with that of Plato, notably due to Aristotle's extensive criticism of the theory of Forms in the *Metaphysics* and his lost work *On the Ideas* (Gerson 2005: 209, 220). However, in view of the Neoplatonic testimony (which is based on all of the extant manuscripts) it would be more accurate to state that Aristotle rejected an inadequate or false theory of Forms, and not the authentic Platonic theory. For instance, Aristotle's notion of the Prime Mover eternally thinking all intelligibles (*ta noēta*) was viewed by the Neoplatonists as recognising the existence of the Forms (Gerson 2005: 209, 220). Further Aristotelian notions regarding Forms that appear to be in harmony (not identity) with Plato are the priority of the intelligible to the sensible, the eternality of form, and the non-identity of form and universal (Gerson 2005: 231).

That Aristotle did not oppose Plato on the reality of the Ideas was explained by Asclepius in his *Commentary on Aristotle's Metaphysics*. In this late Neoplatonic work reference is made to Aristotle's affirmation of the following: (a) that the soul is the place of forms (in *On the Soul*); (b) that intellect in actuality is its objects (in *Metaphysics*); and (c) that intellect in potency acts and intellect in actuality makes (again in *On the Soul*). 'So,' Asclepius concludes, 'Aristotle himself straightforwardly places Ideas in the intellect. Why, then, someone might say, if he is elevating Ideas, does he seem to be quarreling with Plato? We reply that in reality he is quarreling not with Plato, although elsewhere he in fact does quarrel with Plato, but with those who have posited these Ideas as existing by themselves and as having been separated from intellect' (quoted in Gerson 2005: 223). We will touch upon further aspects of the Neoplatonic harmonising of Plato and Aristotle in the next chapter.

Moreover, by affirming that being precedes becoming Aristotle follows his Athenian mentor with regards to ontology. He writes as follows in the *Generation of Animals*: 'When we are dealing with definite and ordered products of Nature, we must not say that each is of a certain quality because it becomes so, but rather that they become so because they are so and so, *for* *the process of becoming attends upon being and is for the sake of being*, not vice versa' (quoted in Ross 1995: 127; italics added).

6: Neoplatonic cosmology

6.1 Introduction

The term Neoplatonism (alternatively Neo-Platonism) has been applied by Western scholars since the eighteenth century to the Hellenic religious-philosophical movement that was launched by the work of Plotinus in the third century. However, the modern distinction between Plato and Neoplatonism is utterly erroneous. There can be little doubt that Plotinus, Porphyry, Iamblichus and Proclus (the dominant figures in Neoplatonism) would have viewed themselves as paleo-Platonists; that is to say, as expositors and defenders of Platonic philosophy (Dillon and Gerson 2004: xiii-xiv). The founders of modern philosophical hermeneutics also rejected the Neoplatonic thesis of harmony between Plato and Aristotle, in the arrogant belief that they understood Plato better than his disciples of the late Classical era did, if not Plato himself (Uzdavinys 2004: xii). This attitude is contrasted by Thomas Taylor with the testimony of Longinus that none of Plato's doctrines had been corrupted in the works of Plotinus. In addition, Plotinus is said to have explicated the Pythagorean and Platonic principles more lucidly than any of his predecessors (Taylor 2010: 79).[21] And in the words of a perceptive recent commentator: 'Looking down upon Plato, Plotinus, and Proclus from the tower of their so-called "Enlightenment", they claimed to have discovered "the real Plato" – one who had to be thoroughly cleansed from the filth of Neoplatonic interpretations. Thus, Neoplatonism was pictured as the root and source of all evils. This highly prejudiced opinion prevailed as unquestioned dogma despite the heroic resistance of such Platonic scholars as Thomas Taylor, and is still prevalent among the contemporary "priests" of current scientistic ideologies. According to the narrow Protestant mentality of the 19th century, and even that of modern secular scholarship, the ancient Hellenic Neoplatonists were madmen, liars and foolish forgers, who preferred illusions and imaginations to sound reason' (Uzdavinys 2004: xii). In this chapter we will endeavour to correct this misinterpretation.

One of the most important predecessors of Neoplatonism[22] was the Syrian philosopher

[21] The Classics scholar Thomas Taylor (1758-1835) deserves lasting credit for first translating the complete works of Plato and Aristotle into English, as well as the Orphic fragments and numerous Neoplatonic works. He also penned a pioneering essay on the rights of animals. However, due to the negative attitude towards Neoplatonism in much of modern scholarship, Taylor 'has been systematically neglected by the narrow-minded scholars of the 19th and 20th centuries', as Algis Uzdavinys remarked (2004: xxviii).

[22] We continue using the term for the sake of convention, without implying any real distinction between Plato and Neoplatonism.

Numenius of Apamea, who lived in the second century A.D. and is recognised as having been both a Pythagorean and a Middle Platonist. Numenius strove to re-establish the primordial *philosophia perennis,* which is manifested in the sacred wisdom of the Indian, Chaldean, Egyptian, Phoenician, and Jewish sages (Uzdavinys 2004: xix). Viewing Socrates and Plato as Pythagoreans, Numenius posited a doctrine of ‘three gods’ that closely resembled the Christian conception of a divine Trinity. In terms thereof the First God was the source of all goodness and rationality, similar to the Good of Plato or the One of the Pythagoreans; the Second God was the mediator between the First God and the physical world, and thus required two natures to interact with both; and the Third God was either the world-soul or the created cosmos (Ferguson 2011: 191-192). The Second God of Numenius appears to be similar to the Logos of Patristic Christianity, acting as the ontological link between the Uncreated and created natures, that is to say between the One and the many. It was further held by Numenius that evil does not arise from God or the Good or their self-withdrawal, but that both good and evil exist as part of primordial reality (Ferguson 2011: 192) – as is axiomatic in Gnosticism, which Plotinus vigorously opposed.

The Neoplatonic hierarchical view of reality rests on two interrelated principles: the simple precedes the complex, and the intelligible precedes the sensible. In both cases the priority is not temporal, Lloyd Gerson remarks, but ontological and conceptual. Accordingly, the complex is explained by the simple and the sensible is explained by the intelligible (Gerson 2005: 33). It is noteworthy that the Neoplatonic distinction between intelligible and sensible worlds does not entail a metaphysical dualism, since the sensible world is not deprived of intelligibility altogether (Dillon and Gerson 2004: xx). Moreover, both the intelligible and sensible realms are rooted, directly or indirectly, in a higher Principle. For the Neoplatonists the first principle is Plato’s Form of the Good, in the light of Aristotle’s testimony that some of the Platonists (‘those who maintain the existence of the unchangeable substances’) equated the One with the Good, whose substance is its unity (*Metaphysics* XIV.1091b). However, the intelligible world (*kosmos noetikos*) could not consist solely of an absolutely simple first principle, and therefore Plotinus divided the intelligible world into a hierarchy of One, Intellect, and Soul (Dillon and Gerson 2004: xx-xxii). Thus, although soul is affirmed as the principle of all life, it is preceded by intellect. This in turn implies that the psychical is explained by the intellectual and not vice versa (Gerson 2005: 33).

In the systematic hierarchy of Neoplatonism the order of the sensible world is explained above all by the principle of the Godhead. In this understanding the Divine has complete explanatory reach, as Lloyd Gerson remarked. And since nothing exists which cannot be explained with reference to the divine Principle, theology and ontology are inseparable. In addition, the Divinity possesses the attributes of benevolence and providence (Gerson 2005: 33). Consequently, in terms of the 'top-down' metaphysics of Neoplatonism, the material is explained by the psychical, just as the latter is explained by the intellectual. In this world-view, being the precise opposite of a materialist one, 'the material world can only be accounted for in terms of the non-material, the visible in terms of the invisible, the measurable in terms of the non-measurable'; accordingly, 'the ultimate truth is enshrined in the latter and not in the former' (Northbourne 1995: 94).

Furthermore, the Neoplatonists strove to present theurgical rites as the summit of philosophy, being 'an attempt to revitalize the ancient transformative wisdom' against the rationalism, hedonism and skepticism that had become dominant in the Academy (Uzdavinys 2004: xix). Their affirmation of theurgy (Greek *theourgia*, literally 'divine-working') is rooted in the Egyptian and Mesopotamian wisdom brought to the Hellenic world by some of the Presocratics. As explained by Algis Uzdavinys, 'Due to this ancient metaphysical and cultic legacy, followers of Orpheus, Pythagoras, Empedocles, and Plato regarded their philosophical tradition as a mystery into which one might be initiated' (2004: xix). Thus Proclus, at the beginning of his *Platonic Theology*, evokes the Platonic mystical vision which had been received by Plato through divine revelation, and preserved by such luminaries as Plotinus, Porphyry and Iamblichus. Recognising that this secret doctrine remained a mystery accessible to only a few, 'It serves to bring home to us the degree to which Platonism was a religion as well as a philosophical system in this period' (Dillon and Gerson 2004: 282). Accordingly, in Neoplatonism discursive thought is combined with spiritual practice in order to attain illumination (*photismos*), direct vision (*epopteia*) of the truth, and union (*henosis*) with the Divine. The Hellenic term *philosophia* is thus the precise equivalent of the Sanskrit *yoga*, denoting a specially adopted lifestyle aimed at salvation of the soul (Uzdavinys 2004: xxii-xxiii). It is abundantly evident that in the Hellenic tradition as represented by the Presocratics, Plato, Aristotle and the Neoplatonists, philosophy is an all-embracing way of life and not mere rationalistic speculation as is commonplace in modern 'scholarly' circles.

For the later Neoplatonists such as Iamblichus, Proclus and Damascius, theurgy (*theourgia*) was a religious-philosophical ritual by means of which the soul could undertake its erotic journey between the immanent and the transcendent, and between insight into its own nothingness and the divine reality itself. Moreover, for these thinkers thought and rite became inseparable, since metaphysical theory was fulfilled in theurgical practice. In this context Iamblichus argued that human thought is unable to return the soul to the gods (i.e. the realm of the Divine), whereas theurgical rites harmonise the human consciousness with the will of the gods and thus prepares it for participation in the Divine realm. As a matter of fact, in the whole metaphysical tradition stretching from Plato and Aristotle up to Thomas Aquinas, thought and practice was conceived as closely interwoven (Goosen 2007: 89-90, 95, 214).

With its insistence on the priority of the intelligible over the sensible, Neoplatonism represents one of the most lasting versions of philosophical idealism in the history of human thought. Combined with its profoundly theistic cosmology, it is not surprising that numerous Christian, Islamic and Jewish thinkers over a period of almost two thousand years have drunk from the Neoplatonic well. Moreover, Neoplatonism is arguably the most advanced form of traditional Indo-European thought in the Western world and thus eminently relevant to the inter-religious dialogue of our time. As affirmed by the British-Indian yogi Bede Griffith, 'Neo-Platonism, as found in Plotinus and later developed by St Gregory of Nyssa and Dionysius the Areopagite, is the nearest equivalent in the West of the Vedantic tradition of Hinduism in the East' (Leclercq 1987: 32). Salient aspects of the cosmology of Plotinus, Porphyry, Iamblichus and Proclus will forthwith be outlined.

6.2 Plotinus

The Hellenic philosopher Plotinus (ca. 205-270) was born in Egypt and studied under the famed teacher Ammonius Saccas in Alexandria. He later travelled to Persia to study their wisdom tradition and afterwards settled in Rome, where he taught philosophy until his death from leprosy (Blackburn 2008: 279). In a collection of treatises titled the *Enneads* (edited by his student Porphyry), Plotinus laid the cosmological and metaphysical foundations of Neoplatonism. As one of the most brilliant thinkers of all time, Plotinus affirmed the classical Indo-European conception of the Divinity as both transcendent and immanent, thereby establishing a balance between apophatic and kataphatic theology (Bradshaw 2006). In addition, through his reworking of the Platonic ontology and epistemology Plotinus provided the conceptual template underlying much of Christian mysticism (Krüger 2007: 144).

To begin with, Plotinus viewed all of reality as grounded in the One (*to hen*), from which all beings arise through emanation. This should not be conceived as a temporal process, but rather as establishing an ontological hierarchy (Oosthuizen 1974: 57). In the words of Plotinus: 'Let the sort of coming to be that is in time not get in our way, since our discussion is concerned with things that are eternal' (*Enneads* V.1.6).[23] The emanationism of Plotinus rests on two related presuppositions expounded by Hellenic thinkers from the Ionians to Aristotle: that unity precedes multiplicity, and that formal reality precedes material reality (Oosthuizen 1974: 57-58). As with his predecessors, Plotinus also strove to explain the relation between the One and the many by means of participation.

Plotinus distinguishes between four modes of being: the One, the Intellect, the Soul, and matter. The first three modes of being are intelligible and named hypostases (*hypostaseis*), comprising a divine Trinity (Oosthuizen 1974: 57-58, 83). As stated by Plotinus, 'There is the One beyond Being; ... next, there is Being and Intellect; and third, there is the nature of the Soul' (*Enneads* V.1.10). The relation between the three hypostases is vividly depicted: 'Intellect is the primary activity from the Good and the primary essence from that which remains in itself. But Intellect is active around the Good, in a way living around it. Soul dances outside this looking at it and, in contemplating its interior, looks at God through itself' (*Enneads* I.8.2). Furthermore, the distinction between Being and Soul is analogous to that between eternity (*aion*) and time (*chronos*). In the *Enneads* (III.7) eternity is stated to be the state and nature (*diathesis kai physis*) of real Being, whereas time pertains to the life of the World-soul (Dillon and Gerson 2004: 274).

The trinitarian scheme of Plotinus is attributed to Plato himself: 'Plato understood that the Intellect comes from the Good, and the Soul comes from the Intellect' (*Enneads* V.1.8). This doctrine was anticipated, Plotinus continues, by Parmenides with his amalgamation of Being with Intellect; by Anaxagoras in positing the first principle (Intellect) as simple and the One as separate; by Heraclitus in viewing the One as everlasting and intelligible; by Empedocles in identifying the first principle, Love, with the One; and finally by Aristotle with his view of the first principle as separate and intelligible, but not as self-thinking (*Enneads* V.1.8-9). With this reasoning Plotinus also implicitly acknowledges the Pythagorean notion of the One as transcendent first principle (Ferguson 2011: 199).

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[23] References to the *Enneads* follow the sequence of book, treatise, and chapter; quotes are from the translation by John Dillon and Lloyd Gerson (2004), unless otherwise indicated.

The realm of being is associated by Plotinus with the Intellect and not with the One itself, which is above being (*hyperontos*) or beyond being (*epekeina ousias*). To be more specific, the One is absolutely transcendent in respect of Intellect, Forms, and Being (*Enneads* VI.8.15; Dillon and Gerson 2004: 174). Nonetheless, as ultimate source of all Being the One provides the foundation (*archē*) and location (*topos*) of all things that exist (*Enneads* VI.9.6; Moore 2001). In the words of Plotinus: 'The One is perfect because it seeks for nothing, and possesses nothing, and has need of nothing; and being perfect, it overflows, and thus its super-abundance produces an Other' (*Enneads* V.2.1; quoted in Lovejoy 1960: 62). Or as vividly depicted by Michael Grant, the One 'pours itself out in an eternal downward rush of generation which brings into being all the different, ordered levels of the world as we know it, in a majestic, spontaneous surge of living forms' (quoted in Ferguson 2011: 200). Thus the One precedes all things and is simultaneously immanent in all things, establishing ontological continuity throughout the cosmos.

Since the One transcends all being and thought, Plotinus held that all speech concerning the One is rooted in things below the One. Therefore concepts can only be applied to the One inasmuch as it is the cause of all things (*Enneads* VI.9.3; Mahoney 2002: 80-81). However, although the divine Essence is unknowable, the One can be known through contemplation (*theōria*) of its power (*dynamis*) (Moore 2001). In addition, although the One is beyond all intelligible reality, it is the source of all intelligible beauty: 'But we say that that which transcends Intellect is the Idea of the Good, a nature that holds beauty in front of itself. So roughly speaking, the Good is the primary beauty. But if one distinguishes the intelligibles apart, one will say that the place of the Forms is intelligible beauty, whereas the Good transcends that and is the source and principle of beauty' (*Enneads* I.6.9). In other words, the One is the ultimate cause of the intelligibility of the cosmos.

The second hypostasis of the Divinity is the Intellect (*ho nous*), which emanates from the One through its self-contemplation. Whereas the One thinks itself as itself, the Intellect thinks itself as other, and thus becomes divided within itself. Through this act of division in the Intellect, the realm of Being is produced (*Enneads* V.1.7; Moore 2005). Strictly speaking, the Intellect is the first principle (*proton arkhon*) of all things that exist, while the One is the eternally present possibility of all existents (*Enneads* V.2.1; Moore 2001). For Plotinus the Intellect is the ontological storehouse of potential beings (*Enneads* V.9.5; Moore 2001).

Plotinus harmonised the Platonic and Aristotelian notions of the first principle by identifying the Good/the One with the ultimate first principle and the Prime Mover with the Intellect (Bradshaw 2006). It should be noted that by associating the Demiurge with the Prime Mover, the Neoplatonists were not ascribing anthropomorphic characteristics to either (Gerson 2005: 129). As a matter of fact, Plotinus insisted that the anthropomorphisms ascribed to the Demiurge by Plato, e.g. sowing or speaking, are not to be taken literally, in the sense of temporality (*Enneads* IV.8.4). This hermeneutical caveat reflects Plato's own assertion that his cosmological dialogue is a 'likely account' (*Timaeus* 29d; Dillon and Gerson 2004: 62).

The contemplation of the One by the Intellect gives rise to an immense variety of separate thoughts, or intelligibles (*noeta*), which are reflections of the power (*dynamis*) of the One that brought the Intellect into existence. These intelligibles are none other than the eternal Forms as postulated by Plato, and through them the Intellect is present in all things as their being and intelligibility (Moore 2005). Plotinus held that since the Intellect contains the totality of the Forms, it serves as archetype for the entire physical world. Each object of sense perception therefore has a prototype in the intelligible realm (Oosthuizen 1974: 104-106).

According to Lloyd Gerson, the Forms contained in the divine Intellect are not to be confused with thoughts (*noēmata*), as some Platonists have done. Plato made a distinction between these concepts in the *Parmenides*, where we find the protagonist explaining to Socrates that the Forms are not thoughts, but objects of thought (132b-c). Plotinus elaborates this theme in the *Enneads*: 'First, then, we should grasp the essence (*ousias*) of the Forms generally, that is, that they do not exist because the one thinking thinks each one, and so that by thinking provides each of them with its existence (*hypostasis*). For it is not because the one thinking thought of what Justice (*dikaiosynē*) is that Justice came to be nor because he thought of what Motion (*kinēsis*) is that Motion came to exist' (VI.6.6; quoted in Gerson 2005: 214).

Plotinus employs the Stoic term *logoi spermatikoi*, or seminal reasons, to indicate the productive 'seeds' that become actualized as distinct from the Intellect (*Enneads* V.9.6-7; Moore 2001). These 'rational seeds' contain the potentialities of all beings, which are generated through the productive power of Being. The relation between Being and Life has been sketched as follows by Edward Moore (2001): 'We may best understand Being, in the context of Plotinus' thought, by saying that it differentiates and makes indeterminate the Ideas belonging to the Intelligence, only in order to return these divided or differentiated ideas, now *logoi spermatikoi*, to Sameness or Unity. It is the process of returning the divided and differentiated ideas to their original place in the chain of emanation that constitutes Life or temporal existence.' Thus Life originates in the return of the *logoi* to Being and Intellect.

The participation of the Forms in the One is illustrated by Plotinus by means of the radii of a circle converging in the centre. The philosopher also employed the metaphor of the sun and sunlight to illustrate the relationship between the One and the Intellect (Oosthuizen 1974: 95, 99). As is the case with the One, the Intellect (*nous*) eludes the grasp of discursive, rational thought (*dianoia*). However, Intellect may be approached through intuitive knowledge (*gnōsis*), which pertains to a higher level of reality than knowledge (*epistēmē*) based on reason (Armstrong 1991:14). This differentiation between intellect and reason is axiomatic in Hellenic thought, but has sadly been lost in the modern Western world.

For Plotinus the third hypostasis of the Divinity is the Soul (*psychē*), which emanates from the Intellect through its contemplation of the One. In its turn, the Soul contemplates the Intellect, which brings forth the cosmos through emanation. Whereas the Intellect became divided within itself through contemplation, the Soul becomes divided outside of itself. This division of the Soul constitutes the cosmos, which is therefore the self-expression of the Soul (Moore 2005). The reciprocity of the Soul's contemplation and action has been depicted as follows by Edward Moore: 'It [Soul] contemplates the Intelligence, its prior in the 'chain of existents,' and also extends itself, through acting upon or actualizing its own thoughts (the *logoi spermatikoi*), into the darkness or indeterminacy of multiplicity or Difference (which is to be identified in this sense with Matter); and by so doing, the Soul comes to generate a separate, material cosmos that is the living image of the spiritual or noetic Cosmos contained as a unified thought within the Intelligence' (2001).

As generator of and ruler over the material world, the Soul forms the material beings according to their prototypes in the Intellect (these being the eternal Forms). Accordingly, Plotinus continues, the World-soul (*psychē tou pantos*) contains the realm of nature (*physis*) as an emanation from the One via the Intellect. Nature is in fact the level where the Soul becomes fragmented into individual, embodied souls (Moore 2001). The position of the individual soul is thus intermediate between the World-soul and nature, so that it displays points of congruence with both realms (Oosthuizen 1974: 112, 114, 121). Due to this interaction between the World-soul and individual souls, Plotinus reasoned, there are two types of care: the universal and the particular (*Enneads* IV.8.2). This indicates respectively the World-soul providing for the body of the universe, and the soul of the individual being providing for his or her body (Dillon and Gerson 2004: 58).

Regarding the relation between Soul and physical nature (*physis*), Plotinus followed Plato's example by using the term 'living being' (*zōion*) for the composite of body and soul in an individual: 'What we should say is that the living being is either a certain kind of body [living], or the sum [of body and soul], or some other third thing that arises from both of these' (*Enneads* I.1.5). It appears that Plotinus views a living being as the product that arises from the combination of body and soul, and not the mere sum thereof (Dillon and Gerson 2004: 278). A distinction is made between the organic shapes (*morphai*) that are present in the sensible world and the Forms (*eidē*) of organisms which are contained in the Form of the Living Being (*Enneads* VI.7.10; Dillon and Gerson 2004: 135).

Throughout the *Enneads* Plotinus employs the term *logos*, in the meaning of 'expressed principle', to indicate the image of the higher as it is found in the lower. The active presence of the *logos* (plural *logoi*) in nature is outlined as follows: 'In fact, the underlying and worked-upon matter comes to form bearing these [hot or cold], or becomes such when the expressed principle, though it itself does not have the property, works on it; for it is not necessary for fire to be added in order for matter to become fire, but rather an expressed principle [to be added], which is not an inconsiderable sign of both the fact that in living beings and in plants the expressed principles are the producers, and the fact that nature is an expressed principle, which makes another expressed principle, a product of it, giving something to the underlying subject, while it is itself static' (*Enneads* III.8.2). In this way Plotinus refers to the rules or laws in the World-soul which are manifested in the 'body' of nature (Dillon and Gerson 2004: 37). We contend that this reasoning implies the operation of natural laws, according to the indwelling *logoi* in the physical world.

Since the Intellect and the Soul arise through contemplation (*theōria*, literally a looking at, viewing, beholding, or observing; L&S 817), the same process applies to nature. Plotinus writes: 'That which comes to be is my vision, my act of silence, a thing contemplated that comes to be by nature, and since I come to be by contemplation that is like this, it is the case that I have the nature of a lover of contemplation. And my contemplating makes the product of contemplation, just as geometricians draw what they are thinking. But with me, I do not draw; rather, I contemplate, and the outlines of bodies materialize as if they resulted from my contemplation' (*Enneads* III.8.4). This passage on the contemplative origin of physical bodies evokes a beautiful personification of nature (Theodossiou et al 2011: 97). Plotinus continues, 'And there exists in me my mother's state and the beings that generated me. Those, too, come from contemplation, and my becoming was through no action of theirs; rather, those greater expressed principles contemplated themselves, and I came to be' (*Enneads* III.8.4). In this context 'mother' refers to the World-soul, whereas the 'beings that generated me' indicates the *logoi* in the soul derived from the Forms contained in the Intellect, according to which nature is constituted (Dillon and Gerson 2004: 39).

The process of emanation from the One via the Intellect and the Soul ends in matter (*hylē*). In Books II and III of the *Enneads* matter is variously described as without magnitude (*ou megethos*), bodiless (*asomatos*), invisible (*aoratos*), without quality (*apoios*), impassible (*apathes*), unalterable (*me alloisusthai*), indestructible (*anolethros*), unlimited (*aoristos*) and indefinite (*apeiron*). These negative aspects of matter are required in order to receive the Forms as images, and as principle of generation and change (Gerson 2005: 107). Matter is therefore the principle of differentiation among existent things for Plotinus (Moore 2001). However, although matter is brought forth by Soul, it is pure passivity and therefore alien to Soul. Viewed from another angle, Soul is the link between the material and non-material realms; that is to say, the mediator between Intellect and matter. Since matter lacks hypostatic being, it is only real in a derived sense (Oosthuizen 1974: 83, 112).

Matter is also viewed by Plotinus as the principle of evil, since it is the final end out of which nothing more can originate. The opposites of good (*to agathon*) and evil (*to kakon*) exist due to the contrary principles found in all being. Since the cosmos is the product of the interaction between Intellect and Necessity (as Plato taught in the *Timaeus*), good is that which comes from God, whereas evil is that which comes from the material substrate (Oosthuizen 1974: 127, 130, 132, 134). However, Plotinus does not view matter as inherently evil. Instead, because matter receives the action of soul it is only evil in relation to soul, to the extent that soul is bound by matter (*Enneads* I.8.14; Moore 2001). Evil is thus viewed as having a parasitic existence (*parahypostasis*), as an inevitable result of the existence of the cosmos (Wikipedia: Neoplatonism).

Since matter represents the final emanation from the One, it marks the point where the power of the One reaches a terminus (Oosthuizen 1974: 131). Yet this recognition does not prevent Plotinus from holding an appreciative view of the sensible world. Because all things exist due to the power of the One, nothing prevents any of them to participate in the nature of the Good, according to the capability of each. As affirmed by Plotinus, 'The most beautiful part of the sensible world, then, is a manifestation of the best among the intelligibles, of their power and of their goodness; and all things, both sensible and intelligible, are eternally connected, the intelligibles existing by themselves, the things that partake always receiving their existence from them, imitating the intelligible nature insofar as they are able' (*Enneads* IV.8.6).

Ultimately, because all things emanate from the One, they have potential (*dynamis*) as their essence. This potential generates energy (*energeia*), so that when individual beings return to the One via the Intellect, their energy returns to their Source (*Enneads* VI.9.6; Wikipedia: Neoplatonism). This return is illustrated by Plotinus with reference to Odysseus' epic journey to his home in Ithaca following the Trojan War, as related by Homer. Thus Odysseus departed first from Circe and then from Calypso to his homeland, even though he had experienced visual pleasures and sensual beauty with them. Similarly, 'Our fatherland, from where we have come, and our father are both in the intelligible world' (*Enneads* I.6.8). This 'metaphysical patriotism', as one may call it, is indeed the highest duty of the human soul.

6.3 Porphyry

Plotinus' student, editor and biographer Porphyry (ca. 234-305) was born in the Phoenician city of Tyre and studied Pythagorean and Platonic philosophy, first with Longinus in Athens and then with Plotinus in Rome (Ferguson 2011: 198). In structuring the writings of Plotinus into six books of nine essays each (the six *Enneads*), Porphyry was undoubtedly aware of the mystical significance of the number nine (Greek *enneas*), being the triad three times. For the Neoplatonists in general, the structure of reality arises from the One unfolding first into the Triad and then into the Ennead: 'The number nine thus expresses the paradigmatic, all-encompassing and still noetic totality' (Uzdavinys 2011: 67).

Porphyry wrote more than seventy books in a wide range of intellectual areas, including numerous commentaries on Plato's dialogues and Aristotle's works, as well as *Lives of the Philosophers*. The latter included a biography of Pythagoras, written to introduce people to Platonic philosophy, of which Pythagoras was thus credited as founder. Anticipating the twentieth-century Traditionalist school, Porphyry believed that the primordial wisdom (*sophia* *perennis*) of the Egyptians, the Hebrews, and the peoples of India and Mesopotamia was essentially identical. Pythagoras was said to have introduced this wisdom tradition among the Greeks, while Plato expressed it more fully than anyone else (Ferguson 2011: 200-201).

In addition, with his influential commentary on Aristotle's *Categories* titled the *Isagoge*, Porphyry incorporated Aristotle's writings into the Neoplatonic curriculum, accepting like all Neoplatonists that Aristotle's philosophy is in harmony with Platonism (Dillon and Gerson 2004: xvii). Porphyry also wrote a work titled *On the Unity of the Doctrine of Plato and Aristotle*, which represents the first systematic attempt to harmonise these Athenian giants (Gerson 2005: 291). The *Isagoge* opens with the following questions in the tradition of Aristotle: 'Do genera and species subsist in themselves, or do they exist only in the mind? If they subsist in themselves, are they corporeal or incorporeal? If they are incorporeal, do they exist in separation from sensible substances or in conjunction with them?' (quoted in Blackburn 2008: 282). In this way the Syrian thinker introduced the problem of universals, which was to achieve such prominence in medieval Scholastic thought.

Building on the teaching of Plotinus, Porphyry declares that the One, as first principle, is also the father of the noetic (i.e. intelligible) triad of Being, Life, and Intellect (*On the Return of the Soul*; Dillon and Gerson 2004: 200). With reference to Plato's declaration that the substance of the Godhead extends over three levels of reality, or hypostases, Porphyry wrote: 'The highest god is the Good, and after him and second there is the Demiurge, and third is the Soul of the Universe; for the divine realm proceeds as far as Soul' (*History of Philosophy*, Book 4; Dillon and Gerson 2004: 203). Since the Good is identical with the One, this statement identifies the Demiurge of the Plato's *Timaeus* with the divine Intellect.

6.4 Iamblichus

The most eminent student of Porphyry, Iamblichus (ca.260-330), was born in the Syrian town of Chalcis. He wrote commentaries on several of Plato's dialogues and Aristotle's works, as well as a voluminous work titled *On the Pythagorean School*, which was introduced by a biography of Pythagoras. In this work Iamblichus incorporated virtually all of Pythagorean thought into Neoplatonism, as well as focusing on the dialogues of Plato and the logic of Aristotle (Ferguson 2011: 201-202). Iamblichus thereby continued the Neoplatonic harmonising of Plato and Aristotle, in terms of which the former was viewed as a Pythagorean and the latter as a Platonist. This implies that Pythagoras, Plato and Aristotle should be recognised as exponents of the same metaphysical tradition, albeit with differences in perspective or emphasis that led to divergent yet compatible formulations of the truth.

The esteem in which Iamblichus was held in the late Classical era is evident from the statement by the Emperor Julian the Philosopher[24] that the Syrian thinker had been posterior in time, but not in genius, to Plato himself (Taylor 2010: 79). Of unknown authorship but attributed to Iamblichus is a Neoplatonic work titled *Ta theologoumena tēs arithmētikēs* (*The Theology of Arithmetic*), in which the mystical, mathematical and cosmological symbolism of the first ten numbers is elaborated. It opens with the statement that the monad is the non-spatial source of number, being called monad on account of its stability – the Greek *monas* is derived from *menein*, to be stable. That the author in all probability belonged to the school of Iamblichus is evident from the following reasoning: 'Everything has been organized by the monad, because it contains everything potentially: for even if they are not yet actual, nevertheless the monad holds seminally the principles which are within all numbers, including those which are within the dyad.' The monad is therefore associated with God, who is seminally everything that exists, self-generated, and the cause of permanence in natures (Waterfield 1988: 35, 37). In this way the metaphysics of Aristotle (potency and actuality) and of Plotinus (seminal principles, or *logoi spermatikoi*) are drawn into Pythagorean numerology, upon which synthesis the author continues to build in the remainder of the work.

It is further stated in the *Theology of Arithmetic* that the dyad is associated with matter, being the sources of differentiation in number and nature, respectively. Just as (primary) matter is definite and formless, so is the dyad incapable of receiving form. Therefore the dyad is subordinate to the monad, just as matter is subordinate to form. The first odd number is the triad, which 'has a special beauty and fairness beyond all numbers, primarily because it is the very first to make actual the potentialities of the monad – oddness, perfection, proportionality, unification, limit.' The triad is also the first number to indicate totality, since all natural process have a beginning, a middle, and an end. In its turn the tetrad is the first number to display the nature of solidity, the latter arising in the sequence point → line → plane → body. The tetrad thus provides the limit of corporeality and three-dimensionality. Accordingly, all sensible things exist in four terms, such as the Aristotelian causes and the Platonic elements. There are also four sources of the cosmos, namely God (by which), matter (from which), form

[24] Known as Julian the Apostate to Christian authors and their secular successors in the Western world.

(by means of which), and result (with what end). The pentad is the first number to encompass the specific identity of all number, being the sum of the first even and uneven numbers (2 + 3). It is associated with all the natural phenomena of the universe, especially as it pertains to life (Waterfield 1988: 40, 42-43, 49-51, 55, 58, 63, 65-66).

Regarding the remaining numbers, the *Theology of Arithmetic* continues as follows. The hexad is the first perfect number, being the sum of its own parts, namely a sixth, a third and a half. Since the hexad is also the product of the first even and uneven numbers (2x3), i.e. male and female, it symbolises marriage of which the function is to produce offspring similar to the parents. In addition, the hexad is the number of the soul, since it gives articulation to the cosmos just as the soul gives articulation to the body. The heptad is not born of any mother and is therefore the number of virginity. Also, the sum of the numbers from the monad to the heptad equals 28, the number of days of the lunar cycle. The octad is the first actual cube, and is characterised by perfection and equilibrium. In its turn the ennead is the first square based on an odd number (3x3). It represents the furthest limit of number, since after nine there is only repetition and no further progression. Finally, the decad is the number of the cosmos as a whole, used by the Creator as a measure of things and for fitting them together harmoniously. It is also associated with power, containing within itself the whole nature of even and odd, and of moving and unmoving (Waterfield 1988: 75, 77, 87, 101, 15, 107, 109, 114-115). In addition, Iamblichus informs us, the Pythagoreans used 'ever-flowing Nature' as a metaphor for the decad, 'since it is, as it were, the eternal and everlasting nature of all things and kinds of thing, and in accordance with it the things of the universe are completed and have a harmonious and most beautiful limit' (quoted in Waterfield 1988: 57).

In the thought of Iamblichus the philosophical dimension became inseparable from the religious dimension. He integrated theurgical elements into Neoplatonism as a strategy to counter the challenge presented by the soteriological aspect of Christianity (Dillon and Gerson 2004: xix-xx). In his work *On the Mysteries of the Egyptians* (the title conferred on it by Marsilio Ficino), Iamblichus defended the necessity of theurgy and presented it as based on Neoplatonic theology, against its criticism by Porphyry (Dillon and Gerson 2004: 221). Astonishingly, this affirmation of metaphysically based religious practice by the later Neoplatonists (keeping in mind that Platonism had from the outset been a profoundly religious philosophy) has been condemned by some modern academics. For instance, *On the Mysteries* has been branded a 'manifesto of irrationality' by E.R. Dodds (Ferguson 2011:

201). With their identification of the ‘supernatural’ with the ‘irrational’, these ‘scholars’ continue to display the ignorance of noetic realities that prevails in modern Western thought.

Iamblichus furthermore affirmed Plato’s teaching on the soul occupying a middle position between those things that are really existent and those things that are subject to generation, i.e. between the realms of being and becoming (*On the Mysteries* II.2; Dillon and Gerson 2004: 228). However, against Plotinus’ notion of the ‘undescended soul’, Iamblichus held that the soul becomes fully embodied in earthly, material reality. The soul’s awareness of its embodied reality is therefore a prerequisite for its return journey to the One. This recognition underlines the necessity of theurgical practice, as opposed to its dismissal by Plotinus and Porphyry (Goosen 2007: 96-97). Furthermore, the priority of the truth that subsists in souls over the opinion (*doxa*) that flows from sense-perception is strikingly described by Iamblichus: ‘And the former indeed receives its perfection in intelligible and divine forms...; but the latter looks to that which is formless, and non-being, and which has a various subsistence... The former contemplates that which is, but the latter assumes such a form as appears to the many. Hence the former associates with intellect, and increases the intellectual nature which we contain; but the latter, from looking at that which always seems to be, hunts after folly and deceives’ (quoted in Taylor 2010: 110-111). Finally, with his traditional, hierarchical view of reality Iamblichus accurately depicts the relation between the human being and the cosmos: ‘Not for your sake was the world generated – but you were born for its sake’ (quoted in Critchlow 2010: 5). This affirmation also serves as a rejection of the anthropocentrism that has underlaid much of the millenniums-old human onslaught against the Earth.

6.5 Proclus

The works of the last major Neoplatonist, Proclus (412-485), comprise the most complete extant exposition of Platonism. Born in the imperial capital Constantinople and educated in Alexandria, Proclus rose to the prestigious position of head teacher, or scholarch, of the Academy in Athens. Thus Proclus experienced the three main centres of Hellenic intellectual culture, both ‘pagan’ and Christian. Among his works count commentaries on a number of Plato’s dialogues, including *Parmenides, Republic* and *Timaeus*, and on the first book of Euclid’s *Elements of Geometry*. Proclus also wrote two major works of systematic philosophy and theology, namely *Elements of Theology* and *Platonic Theology*, in which the Neoplatonic synthesis of Plato, Aristotle and the Stoics is continued. The Latin and Arabic translations of the latter two works became highly influential in medieval philosophy, both Christian and

Islamic. Among notable Christian thinkers influenced by Proclus the names of Dionysius the Areopagite, Boethius and Eriugena stand out (Dillon and Gerson 2004: xiii; Blackburn 2008: 293). This legacy must surely count among the greatest ironies in the history of thought, since Proclus was a vocal opponent of Christianity. His philosophy entered Christian thought mainly through the writings of Dionysius (Ferguson 2011: 263), in which form mature Neoplatonism became an integral dimension of both Orthodox and Catholic theology.

Theology (*theologia*, i.e. discourse on the nature of God and the gods) is conceived by Proclus as a branch of theoretical philosophy, as had earlier been postulated by Aristotle in his *Metaphysics* (Dillon and Gerson 2004: 264, 287). Following the example of Plato in the *Timaeus* and in affirmation of his own religious devotion, Proclus opens both the *Platonic Theology* and the *Commentary on Parmenides* with an invocation to the gods and goddesses. In addition, Proclus employed the Homeric image of the Golden Chain to depict both the vertical connection with first principles and the horizontal succession of its qualified teachers. Since the Golden Chain is both the chain of theophany or divine descent (*demiourgikē seira*) and the ladder of human ascent (through the theurgic rites), Proclus held that the philosopher standing in this tradition has to be a hierophant of the entire cosmos (according to Marinus in his *Life of Proclus*, 19.28). In his *Platonic Theology*, Proclus argued further that all Hellenic theology derives from the Orphic mystagogy, first through Pythagoras and then through Plato. The genius of Plato lay in combining the inspired, symbolic and anagogic[25] approach of the Orphic and Pythagorean tradition with the rational, scientific and demonstrative approach of his mentor Socrates (Uzdavinys 2004: xxi-xxii, xxiv-xxv).

The following propositions from the *Elements of Theology* are especially pertinent to cosmology:

Proposition 1: ‘Every multiplicity participates in some way in unity’ – this is the basic metaphysical principle expounded by Plato (in the *Parmenides*) and Plotinus (Dillon and Gerson 2004: 264);

Proposition 7: ‘Everything that is productive (*paragein*) of something else is superior to the nature of its product’ – affirming the priority of the maker over what is made, following Plato (in the *Philebus*) and Plotinus (Dillon and Gerson 2004: 265);

Proposition 11: ‘All things that exist proceed from a unique cause, the first’ – here Proclus

[25] Greek *anagōgikos*, ‘leading on high’ (Taylor 2010: 104); also *anagōgeus*, ‘one that leads up’ (L&S 48).

establishes that the final cause of all things is also their efficient cause (Dillon and Gerson 2004: 266);
Proposition 12: ‘All that exists has the Good as its first principle and cause’ – elsewhere (in the *Commentary on Parmenides*) Proclus emphasises that the Good is not only the final cause of the cosmos, as Aristotle recognised, but also its productive cause (Gerson 2005: 128);
Proposition 13: ‘Every good is such as to unify what participates in it; and all unification is a good; and the Good is identical with the One’ – this implies that everything which exists partakes of the Good, according to their particular natures and by striving to fulfil these (Dillon and Gerson 2004: 348);
Proposition 20: ‘Beyond all bodies is the essence of the soul; and beyond all souls is the intellectual nature; and beyond all intellectual substances, the One’ – it is here argued that all bodies receive their motion from self-moved soul, that Intellect is an unmoved cause of motion, and that the One is superior to even spiritual motion (Dillon and Gerson 2004: 269);
Proposition 25: ‘Everything that has attained its perfection proceeds to generate those things that it is capable of producing, imitating in this the unique principle of all things’;
Proposition 28: ‘Every producing cause brings things like itself into existence before what is unlike itself’;
Proposition 29: ‘All procession (*proodos*) is accomplished through the likeness of secondary entities to their primaries’;
Proposition 35: ‘Every effect both remains in the cause, and proceeds from it, and reverts on it’ – this is the clearest expression of the Neoplatonic dialectic, which is valid within any level of true being (Dillon and Gerson 2004: 272);
Proposition 48: ‘Everything that is not eternal either is composite or has its existence in something else’;
Proposition 53: ‘Prior to all eternal entities there is Eternity, and prior to all temporal ones there is Time’ – it appears that Eternity and Time are thus hypostatised, in order to rule over their respective realms (Dillon and Gerson 2004: 273); and
Proposition 57: ‘Every cause both exercises its activity prior to its effect and generates a greater number of terms following on it’ – in this way causality is extended throughout the created order, visualised as concentric circles emanating from the One (Dillon and Gerson 2004: 274);
Proposition 67: ‘Every whole is either prior to its parts, or made up of its parts, or is in the part’ – the first two of these alternatives derive from Plato (in the *Theaetetus*), with Proclus adding the third (Dillon and Gerson 2004: 277);

Proposition 113: ‘The whole divine number (*arithmos*) has the character of unity.’

From the above propositions it appears that Proclus conceives of universal nature as entailing three interlinked aspects: (i) the eternally remaining First Principle (*monē*), (ii) a procession (*proodos*) thereof through the Forms into their results, and (iii) a return (*epistrophē*) of the results through the Forms unto the First Principle (Sheldon-Williams 1967: 431). In other words, the cosmos comprises a ceaseless movement from Being into becoming and a return into Being (Moore 2005). For Proclus the dynamic nature of the cosmos is due to the erotic love (*eros*) through which the multiplicity of things participate in their causes and ultimately in the One. This notion of a love relationship between beings and Being had earlier been evoked in poetic-mythical language by Plato in the *Phaedrus*, with the mind flying on wings like those of Eros towards the Good (Goosen 2007: 42). Proclus elaborates this ontological interaction in *Elements of Theology*: ‘But all things desire the Good, and each attains it through the mediation of its proximate cause; therefore each has appetition of its own cause also. Through that which gives it being it attains its well-being; the source of its well-being is the source of its appetite; and the primary object of its appetite is that upon which it reverts’ (quoted in Goosen 2007: 94). Here we encounter an echo of the Empedoclean notion of the world of multiplicity arising through the agency of Love mixing and uniting unlike things.

Regarding causality, Proclus viewed Plato as the only one who presented both the contributory causes of physical things, in the shape of the ‘receptacle’ (in the *Timaeus*) and the form-in-matter on the one hand, and the prior, primal causes such as the efficient, the paradigmatic, and the final causes on the other hand. The contributory causes (i.e. form and matter) are dependent on the true causes (i.e. the Good, the intelligible Living Being, and the Demiurge) from which they are derived and for the sake of which they came into being. Proclus concludes that the Good is the sole cause of the totality of the intelligible world (*Commentary on Timaeus*, 1; Dillon and Gerson 2004: 333). In this way the Aristotelian scheme is expanded into formal, material, efficient, paradigmatic, and final causality.

Based on his reading of Plato’s dialogues *Parmenides* and *Timaeus*, Proclus defines a Form as follows: ‘The Idea is the paradigmatic cause (*paradeigmatikēn*) of the things that are eternally (*aei*) constituted according to nature’ (quoted in Gerson 2005: 210). The procession of the Forms into objects of sense perception is outlined by Proclus in terms of the Neoplatonic ontology. At first the Forms are all contained in the realm of true Being. Primary among these

Forms is the *tetraktys*, the Pythagorean principle of numerical order. On the second level the Forms proceed into souls by means of the Demiurge implanting the reason-principles (*logoi*) as psychic essences (which was taught by Plato in the *Timaeus*, Proclus reminds us). On the third level the Forms are established in the natural essences that precede sensible things, having received their *logoi* from the intelligible world. Finally the reason-principles generate sensible things from the formless, indeterminate receptacle and preserve them as living beings (*Commentary on Parmenides*, I.3; Dillon and Gerson 2004: 298-299).

Proclus sketches the presence of the Forms in the various grades of being by applying the Neoplatonic principle that 'All things are in all, but in a manner proper to the essence of each' (Dillon and Gerson 2004: 299). On the intelligible level the Forms exist primarily in and for themselves, and not as images of anything higher. Next, the forms in souls have their being in a secondary way, 'and thus are likenesses of the intelligibles.' On the third level, the forms in nature are likenesses of likenesses, 'for it is through the forms in souls that the reason-principles in nature come to be and are.' Finally, the forms in sensible things are images only, 'for the Forms end their procession at what is unknowable and indeterminate. There is nothing after them, for all the reason-principles reach their final term in sensible things' (*Commentary on Parmenides* I.3; Dillon and Gerson 2004: 300). In other words, the Forms are variously encountered on four levels of reality: in primary mode on the intelligible level, in secondary mode as likenesses on the psychic level, in tertiary mode as likenesses of likenesses on the level of nature, and in quarternary mode as images on the sensible level.

For the Neoplatonists the central metaphysical question concerned the relation between the One and the many, or to be more precise, between the multiplicity of existing things and their origin in the realm of the divine One. As was done by Plato, Plotinus and Iamblichus, so also Proclus explained the relation between the One and the many through the notion of participation (Goosen 2007: 93). This participation is strictly ordered, Proclus argued: 'For it is in accordance with the distinctive properties of the principles participated in that differences within a participant order are determined. And it is not everything that participates in everything (for there can be no conjunction of things that are wholly unlike each other), nor does any chance thing participate in any chance thing, but it is what is akin that is joined to each thing, and from it each proceeds' (*Elements of Theology*, Proposition 123).

In the *Elements of Theology* (Propositions 23 and 24), Proclus also distinguishes between that which participates (*to metechon*), that which is participated in (*to metechomenon*), and that which is unparticipated (*to amethekton*). The latter term is also rendered as imparticipable, and signifies that which is not consubsistent with an inferior nature (Taylor 2010: 107). Lloyd Gerson illustrates this distinction by means of the following example: (i) a large thing, (ii) the largeness in the large thing, and (iii) the entity that possesses largeness paradigmatically. With this distinction between the paradigmatic nature which is unparticipated (i.e. transcendent) and the image thereof which participates (i.e. the immanent), Proclus elegantly answers the question as to whether the Forms are transcendent or immanent. Moreover, the participated version of a Form could feasibly be viewed as the Neoplatonic equivalent of Aristotle's 'en-mattered form' (*henulon eidos*), which in the *Metaphysics* and the commentary thereon by Alexander of Aphrodisias signifies the presence of forms in matter (Gerson 2005: 212-213).[26]

The relation between Intellect and participation is portrayed by Proclus through the main characters in Plato's dialogue *Parmenides*.[27] Thus Parmenides is the analogy of Being, his disciple Zeno of Life, and Socrates of Intellect. These pertain respectively to complete and unparticipated intellect, to intellect that is participated, and to individual and participated intellect. Proclus furthermore draws analogies between Pythodorus and the divine World-soul, Antiphon and the intermediary daemonic soul, and Cephalus and the individual soul that is conversant with nature. In this hierarchical way, 'all events in nature share in intelligibles through the mediation of the forms in souls' (*Commentary on Parmenides* I.4; Dillon and Gerson 2004: 301-302). Moreover, Proclus argues in his *Commentary on Euclid's Elements*, since the individual soul contains projections (*probolai*) of the Forms existing primarily in the Intellect, mathematical forms such as triangles and circles exist as reason-principles (*logoi*) in the soul, and are not mere concepts derived from sense perception as was held by Aristotle (Dillon and Gerson 2004: 344).

Proclus' appreciative view of the physical world is evident from the following reasoning: 'From this it clearly follows that even at the level of natural bodies unity and multiplicity coexist in such a manner that the one Nature contains the many natures as dependent on it, and, conversely, these are derived from one Nature – that of the whole' (*Elements of*

[26] It is noteworthy that the latter scholar, regarded as the greatest among the Peripatetic commentators on Aristotle, was explicitly anti-Stoic but not anti-Platonic (Gerson 2005: 294).

[27] Interestingly, Proclus reiterates the 'very ancient' subtitle for this dialogue, namely *About Ideas*, thus asserting its metaphysical provenance against those who viewed the *Parmenides* as an exercise in logical method. That is to say, the dialogue is an enquiry into Being, including all things which derive from the One (*Commentary on Parmenides* I.5; Dillon and Gerson 2004: 303, 310).

Theology, Proposition 21). This implies that Nature functions as a kind of fourth hypostasis for Proclus, ruling the realm of non-rational living beings (Dillon and Gerson 2004: 271). In addition, Proclus views the composite and multiform realm of generation (*genesis*) as conjoined with time (Taylor 2010: 106), thus evoking Plato. Ultimately Nature is rooted in the One, Proclus affirms: ‘That, then, is the One the principle of all generation both for the manifold powers of nature, and for particular natures, and for all those things under the sway of nature’ (*Commentary on Parmenides*, VI 1046; Dillon and Gerson 2004: 326).

The relation between matter and evil is explored by Proclus in his monograph *On the nature and origin of evil*. To begin with, it is argued that just as the Good transcends Being, so evil transcends the Form of Non-being (which for Plato is the Form of the Different; *Sophist* 256d-e), and is thus even further removed from the Good than is Non-being. Further, in creating this world the Demiurge willed it to be devoid of evil as far as possible, as Plato stated in the *Timaeus* (30a). However, Proclus continues, since evil is the destructive element in each thing, and since generation would be impossible without destruction, evil must exist. Paradoxically, since evil thus contributes to the preservation of the universe, it is good by existing. Proclus therefore affirms that evil has a two-fold aspect: that which is strictly evil, as transcending non-being; and the evil that exists mixed with goodness (*On the nature and origin of evil*, 3, 5, 9; Dillon and Gerson 2004: 348).

Proclus holds a more nuanced view of matter than Plotinus, who associated it with evil (albeit in a qualified sense) and privation. If matter is indeed evil, then either the Good is the cause of evil or there are two principles of existing things, namely primary Good and primary Evil. Proclus counters these false alternatives with a variety of arguments on which we do not need to dwell, except to note that the role of matter as ‘mother’ or ‘nurse’ (i.e. as the receptacle of becoming in Plato’s *Timaeus*) in the realm of generation is acknowledged. Accordingly, in the sense that matter came to be on account of a good, it is good, but not unqualifiedly so; and in the sense that matter is the lowest of the things that exist, it is evil, but not unqualifiedly so. Ultimately matter is neither good nor evil, Proclus concludes, but it is necessary. And evil does not exist in itself, but as a privation and lack of goodness (*On the nature and origin of evil*, 31, 32, 37, 51; Dillon and Gerson 2004: 354-355, 357-358).

Since matter is moved by soul, we should briefly consider the psychology of Proclus. In the *Elements of Theology* it is stated that every soul is an incorporeal substance and separable from the body (Proposition 186), is indestructible and imperishable (Proportion 187), contains all the Forms that Intellect contains primarily (Proposition 194), and is all things, both sensible entities in the mode of an exemplar and intelligibles in the mode of an image (Proposition 195). Since Soul proceeds from Intellect, the individual soul possesses the reflections (*emphaseis*) of the Forms, albeit in a secondary mode. Moreover, because soul participates in Intellect it is able to impart the reason-principles (*logoi*) of material things, thereby causing bodies to exist. Finally, against Plotinus' notion that a part of the individual soul remains above the sensible realm, Proclus argues in favour of full indwelling: 'Every particular soul, when it descends into the realm of generation, descends completely; it is not a case that there is a part of it that remains above and a part that descends' (*Elements of Theology*, Proposition 211; Dillon and Gerson 2004: 278-280).

Regarding epistemology, Proclus followed Empedocles and Plato in asserting that at every level of reality, 'like is known by like'. Thus the sensible realm is known by sensation, the heavenly realm by opinion or belief, the realm of Soul by discursive reasoning, and the intelligible realm by intellection. When the soul contemplates the universe, Proclus continues, it sees only the images of true beings, but when it turns into itself the soul perceives its own reason-principles (*logoi*); the latter being the projections within the soul of the eternal Forms. In the words of Proclus, 'For all things are within us in a manner proper to soul, and by reason of that we have the natural capacity to know everything through awaking the powers within us and the images of all beings' (*Platonic Theology* I.3; Dillon and Gerson 2004: 290-291).

Thus in true Platonic fashion a hierarchy of knowledge is postulated, which from lowest to highest is represented by sensation (*aisthēsis*), opinion or belief (*doxa*), reasoning (*dianoia*) and thought, or intelligence (*noēsis*). Opinion is the lowest power of the rational soul, limited to knowing the universal in particulars. That is to say, opinion can only know that a thing is (*oti*), but not why it is (*dioti*) (Taylor 2010: 105). In contrast with discursive reasoning that strives toward rational, 'scientific' knowledge, intellection entails a non-discursive dialectic which implies the soul's affinity with *ta noēta*, the Forms (Uzdavinys 2011: 76). With its firm ontological basis, this Neoplatonic epistemology is superior to much of modern thought.

6.6 Harmonising of Plato and Aristotle

Although the Neoplatonic philosophers saw themselves as true Platonists, they did not hesitate to assimilate elements from the Aristotelian and Stoic teachings that were deemed to be compatible with Platonism. The Neoplatonic harmonising of Plato and Aristotle is evinced by the fact that their curriculum for students of philosophy began with a study of Aristotle's *Categories*, as introduced by Porphyry's *Isagoge*, and followed by the study of Plato (Gerson 2005: 76, 101). The principal feature of this harmony is that Aristotle's thought is authoritative for the sensible world, just as Plato's thought is for the intelligible world. Moreover, Aristotle's doctrines on the intelligible world could, with certain reservations, be fitted into Plato's doctrines thereon. It has been suggested by John Dillon and Lloyd Gerson (2004: xvii) that this conceptual accommodation is analogous to Newtonian mechanics being fitted into quantum mechanics in the twentieth century. In other words, Aristotle's philosophy is embraced by Platonism, just as Newton's mechanics is embraced by quantum mechanics.

Interestingly, the Neoplatonists view the logic of Aristotle as a mode of reasoning that pertains only to the physical realm (Dillon and Gerson 2004: 225), and therefore not to the intelligible world. Analogously, Aristotle's categories of reality are restricted to this (physical) world, as we noted in an earlier chapter. The restriction of Aristotelian logic to the sensible world coheres with the traditional differentiation between intellect (*nous*) and discursive reason (*dianoia*), being respectively universal and individual in scope (Schuon 1984: xxix-xxx). That is to say, intellect pertains to the higher, intelligible world and reason to the lower, sensible world. It should, however, be kept in mind that Plotinus ascribed the discursive power of the soul to the presence of Intellect. Thus the soul's thinking is conceived as an image of the intellect's thinking, so that discursive reason (*dianoia*) arises due to intellect (*dia nou*), and not in separation from it (*Enneads* V, 3, 6; Dillon and Gerson 2004: 93). This implies that for reason to provide us with a reliable account (*logos*) of the physical world (*kosmos*), it has to be enlightened from above, i.e. by Intellect.

The Neoplatonic approach enabled them to reconcile, albeit with qualifications, the ostensibly variant views of Plato and Aristotle on matter. In the *Physics* (I, 192a) Aristotle makes a distinction between matter and privation (*steresis*), which are related to relative and absolute non-being respectively, while also charging Plato with overlooking privation. According to Plotinus, Plato and Aristotle held similar views on matter, except for the latter's differentiation between matter and privation. Against this distinction Plotinus argued that matter cannot be an element in a mixture, as in Aristotle's composite of matter and form comprising substance, and therefore matter and privation are identical. Simplicius later suggested that Plato did recognise the principle of privation, which is none other than the receptacle of becoming.

However, Simplicius continues, Plato did not introduce the term 'privation', since it is an accidental cause (Gerson 2005: 107-108).

Regarding the relation between form and matter, the Neoplatonists employed Aristotle's 'formal cause' to formulate the expression 'en-mattered forms' (*ta enhyla eidē*), in order to indicate the forms of sensible objects. In this way the Aristotelian 'sensible form' became integrated into the Platonic doctrine of separate Forms, on the grounds of Plato's distinction between 'likeness in us' and 'Likeness itself' (*Parmenides* 130e). In addition, the notion of en-mattered form enabled the Neoplatonists to accept the concept of matter (*hylē*) as legitimately Platonic. This is important in their understanding of the receptacle of becoming (as depicted in the *Timaeus*) as well as the Platonic association of evil with matter (Dillon and Gerson 2004: xviii-xix). It should be kept in mind that the latter association is a qualified and nuanced one, as we noted earlier.

The Neoplatonists also strove to harmonise Plato and Aristotle regarding causality. In his *Commentary on Timaeus*, Proclus stated that the science of nature comprises three divisions, dealing with respectively (i) matter and material causes, (ii) formal causes, being a more important factor than (i), and (iii) creative (= efficient), paradigmatic, and final causes – in terms of which (i) and (ii) are viewed as contributory causes (Dillon and Gerson 2004: 332). According to the sixth-century commentator Simplicius, among principles (*archai*) Aristotle accepted two causes (*aitiai*), namely the productive (*poietikon*) and the final (*telikon*), as well as two contributary causes (*synaitiai*), namely form (*eidos*) and matter (*hylē*), of which the latter are elements (*stoicheia*). Plato added two more causes to Aristotle's four-fold scheme, Simplicius continues, namely the paradigmatic (*paradeigmatikon*) to the causes and the instrumental (*organikon*) to the contributary causes (*Commentary on Aristotle's Physics*; Gerson 2005: 102). Thomas Taylor enumerated Plato's six causes as follows: the final (on account of which), the paradigmatic (with reference to which), the demiurgic (through which), the instrumental (according to which), the formal (from which), and the material (in which) (2010: 108). Aristotle's contraction of Plato's six causal principles into four was explained by a contemporary of Simplicius, John Philoponus. According to this Christian thinker, Aristotle assimilated the paradigmatic cause to the form and the instrumental cause to the material cause (*Commentary on Aristotle's Physics*; Gerson 2005: 102). The causal scheme of Plato should thus be viewed as embracing that of Aristotle.

Since Platonism is a thoroughgoing theistic philosophy, the Neoplatonic harmonising of Plato and Aristotle also extended to theology. Whereas Plato depicted the Divinity alternatively as the Good and the One, Aristotle saw the Prime Mover as the first principle. In the *Republic* the Good is declared to exist beyond being (*hyperousias*), which to the Neoplatonists meant that the Good is also beyond thought, or *noēsis* (Bradshaw 2006). This recognition of divine transcendence was developed by Plato in the *Parmenides,* in which the One is described as indivisible, unlimited and shapeless, neither at rest nor in motion, neither like nor unlike anything else, not partaking of time or being, and not an object of knowledge (137c-142a). According to Aristotle, some of the Platonists identified the One with the Good (*Metaphysics*, XIV 1091b). Plotinus harmonised this Platonic theology with Aristotle's notion of the Prime Mover, which became identified with the divine Intellect rather than the One itself. It is therefore legitimate to view the Prime Mover in relation to intelligible reality as Aristotle's version of the Demiurge in relation to the Forms (Gerson 2005: 130).

Nonetheless, this Neoplatonic project was by no means uncritical in nature. For example, while Plotinus did not hesitate to incorporate Aristotelian and Stoic doctrines when deemed to be in harmony with Plato, this harmonisation is accompanied by criticism (Gerson 2005: 173). Another instance is Proclus, who charged Aristotle with arranging his whole treatment of nature both derived from and in rivalry with that of Plato. In this Neoplatonist thinker's *Commentary on Timaeus*, Aristotle is said to have derived his general principles of all things (e.g. form, substrate, and motion) from Plato's teaching on space (Dillon and Gerson 2004: 337-338). However, these criticisms by Proclus should not at all be viewed as implying rejection of Aristotle, which would have been unthinkable to any of the Neoplatonists.

Finally, as remarked by Lloyd Gerson in his magisterial work on the Neoplatonic harmonising of Plato and Aristotle, the latter 'in holding both to the nontemporal order of the universe and the explanatory subordination of physics to first philosophy, would seem to be committed to the hierarchical top-down approach of Platonism.' Accordingly, for the Neoplatonists 'harmonization is made plausible by treating Plato as providing explanations for the possibility of that which Aristotle describes and categorizes' (Gerson 2005: 128, 83). In the light of the abundant Neoplatonic testimony on the harmony between Plato and Aristotle, the modern academic fashion of presenting Aristotle as an anti-Platonist has to be rejected as based on ignorance, if not outright arrogance.

7: Implications of Hellenic cosmology for evolutionary biology

7.1 Introduction

Before considering some of the implications of Hellenic philosophy for evolutionary biology, it should be noted that the combined Presocratic, Platonic and Neoplatonic cosmology held an all-embracing vision of created and uncreated, natural and supernatural. This cosmic vision later inspired such spiritual and literary luminaries as Gemistos Plethon, Goethe, Blake and Yates (Sherrard 2002: 190). However, it has become customary in modern and postmodern thought to view the grand metaphysical tradition represented by *inter alia* Plato, Aristotle, Proclus, Augustine, Dionysius, Maximus and Thomas Aquinas as entailing metaphysical dualism and hence a rejection of material or immanent reality. This accusation is a false one, since according to traditional metaphysics human thought originates in the act of wonder at the participation of the immanent in the transcendent, that is to say the interaction between beings and Being (Goosen 2007: 251-253, 343, 353).

For both Plato and Aristotle the origin of philosophy lay in wonder (*thauma*; hence *thaumazein*, to regard with wonder; L&S 312). Their philosophy entailed 'the contemplation (*theōria*) of the manifested cosmic order, or of the truth and beauty of the divine principles (be they visible stars or invisible noetic archetypes)' (Uzdavinys 2004: xvii). Plato has Socrates declaring as follows in the *Theaetetus*: 'For this is an experience which is characteristic of a philosopher, this wondering: this is where philosophy begins and nowhere else' (155d). And in the words of Aristotle, 'Since we are seeking this knowledge [i.e. philosophy], we must enquire of what kind are the causes and the principles, the knowledge of which is Wisdom... And these things, the most universal, are on the whole the hardest for men to know; for they are farthest from the senses... For it is owing to their wonder that men both now and at first began to philosophize... And a man who is puzzled and wonders thinks himself ignorant (whence even the lover of myth is in a sense a lover of Wisdom, for the myth is composed of wonders)' (*Metaphysics* Book I, 982a, 982b).

This non-dualistic cosmology is by no means limited to Hellenic thought, as is evident from the Indian philosophy of Advaita Vedanta. As the Sanskrit term for non-duality, *Advaita* asserts the identity of ultimate reality, or the ground of being (*Brahman*) which makes possible time, space, and the natural order, with the self or soul (*Atman*). This theistic-ontological conception implies that the empirical world, like the self, is to a greater or lesser degree a manifestation of God (Blackburn 2008: 7). In other words, physical reality (Greek *physis*), is a theophany, or God-appearance, in varying degrees.

Initially the Greek term *kosmos* meant order, from which it came to signify the world or universe, on account of the latter's (perceived) perfect arrangement (L&S 389). The noun *kosmos* is derived from the verb *kosmeō*, which means 'to set in order', or setting things in their proper order. Hence the term *kosmos* also has an aesthetic dimension in the sense of ornament or adornment (Vlastos 1975: 3). This notion of cosmic setting in order implies the teleological concepts of design and lawfulness. A related Hellenic notion is that of *harmonia*, which is exhibited by the handiwork of craftsmen. Harmony pertains eminently to a lyre which is in tune, and furthermore indicates all that is put together by nature. *Harmonia* thus implies balance or attunement, like the cognate terms *krasis* (mixing, blending) and *synthesis* (putting together, compounding) (Thompson 1992: 7).

In the Hellenic cosmology both mechanism and teleology are encountered. Mechanism is the belief that everything can be explained in terms of quantitative laws that govern the interactions of material particles, thereby also explaining the other properties of matter. In biology, mechanism views animals as material systems, and is therefore hostile towards teleology (Blackburn 2008: 228). In contrast, teleology or final causality postulates that there are ends or purposes for all things – from the Greek *telos*, meaning end. Teleology is prominent in the Aristotelian view of nature, whence it profoundly influenced Christian theology (Blackburn 2008: 360). Etienne Gilson has pointed out that both teleology and mechanism belong to the philosophy of the science of nature, and therefore natural science cannot 'prove' or 'disprove' final causality. Moreover, for the philosopher of nature it is not necessary for natural teleology to be perfect to acknowledge its existence (Gilson 2009: 20, 143). The cosmos is the product of the interaction between the divine Intellect and irrational Necessity, as depicted by Plato in the *Timaeus*, and it is therefore good but not perfect.

7.2 The Presocratics

Two recurring Presocratic notions that are relevant to our thesis are hylozoism and pan-psychism. According to the doctrine of hylozoism (from *hylē*, matter and *zōē*, life) all matter is endowed with life (Blackburn 2008: 174). A related notion is that of pan-psychism, which conceives all varieties of matter as involving consciousness. Since the natural world produces living creatures, it should be thought of as itself alive and possessing a world-soul (Blackburn 2008: 265). The ecological implications of hylozoism and pan-psychism are manifold, not the least of which entails a damning indictment of the rampant human exploitation and degradation of the Earth and its biosphere over thousands of years.

According to Anaximander there exists a cosmic justice (*dikē*) that maintains the balance among the primary elements of water, earth, air and fire. This notion is implied by the Milesian thinker's only extant fragment (preserved by the Neoplatonist commentator Simplicius): 'The things that are perish into the things out of which they come to be, according to necessity, for they pay penalty and retribution to each other for their injustice in accordance with the ordering of time, as he says in rather poetical language' (quoted in McKirahan 1994: 43). By 'paying penalty and retribution to each other', domination of one element over the others is prevented, which in turn preserves the structural integrity of the cosmos throughout the ages (Theodossiou *et al* 2011: 94). Anaximander's notion also anticipated the twentieth-century theory of dynamic equilibrium in ecosystems. This biological theory recognises that creation, destruction, regeneration and decomposition occur continuously and alternate periodically. For instance, new organisms are born when old ones die, since they are composed out of the dissolved materials of dead organisms (Theodossiou *et al* 2011: 94). In addition, Anaximander recognised that the generation and destruction of things occur 'in accordance with the ordering of time.' This insight applies to the observed rhythmic cycles of biological systems, with populations alternately increasing and decreasing in number (Theodossiou *et al* 2011: 94). Anaximander thus became the first Western thinker to conceive of the cosmos as ruled by lawful necessity (Dreyer 1975: 31).

Furthermore, Anaximander depicted the origin of living beings in terms of new, more complex things arising out of simpler existing things. According to Censorinus, Anaximander held that in the beginning from heated water and earth there arose fish-like beings. Inside these aquatic creatures humans grew as embryos until they reached puberty, whereupon the containers burst open and men and women came forth (McKirahan 1994: 42). This could be viewed as an evolutionary understanding of the organic world, in terms of which all life began in the sea, and later terrestrial animals including humans developed from aquatic animals (Swift 2002: 58). Moreover, Anaximander depicted in mytho-poetic language the traditional understanding of evolution, namely the un-folding of that which is in-folded.

The numerological cosmogony of Pythagoras and his followers is of the utmost importance for the notion of evolution according to natural law. The sequence of generation from numbers to the cosmos was summarised as follows by Alexander Polyhistor in his *Pythagorean Notebooks* (McKirahan 1994: 101): from the unit and the indefinite dyad arise numbers, which give rise to points, which give rise to lines, which give rise to plane figures, which give rise to solid figures, which give rise to sensible bodies. The cosmogonic sequence can therefore be depicted as: unit and indefinite dyad → numbers → points → lines → plane figures → solid figures → sensible bodies. The latter consist of the four elements of fire, water, earth and air; these elements, Alexander continues, 'interchange and turn into one another completely, and combine to produce a universe (*kosmos*) animate, intelligent, spherical, with the earth at its centre, the earth itself being spherical, and inhabited round about' (quoted in McKirahan 1994: 101).

This geometrical cosmogony of the Pythagoreans could equally well be stated in terms of an evolutionary coming-to-be. Thinkers as diverse as Clement of Alexandria, Samuel Coleridge and René Guénon employed the geometrical symbol of the point in this context. In terms thereof, the point harbours an (innate) tendency to 'spill over the edges of its invisible and dimensionless essence into the dimensions of the things that are seen' (Cutsinger 2007: 13), thereby producing a line. But since the latter only actualises the possibilities of the point in one dimension (i.e. length), the point seeks a further dimension of breadth, and thus the plane is evolved. However, since the two-dimensional plane is still invisible and incorporeal, the point evolves (or 'explodes') into a third dimension of depth, whereby the solid is produced. In this way the terrestrial world of material objects comes to be, which is the domain wherein the evolution of species occurs (Cutsinger 2007: 14, 23).

In the Pythagorean understanding, therefore, all things arise from the one (*monas*), which is the number of the Godhead. Number is therefore the cosmic principle from which all things arise and which explains all (Dreyer 1975: 36). For the Pythagoreans the progression from Principle to Manifestation entails a movement from numbers to the physical world, by means of geometrical figures. Interestingly, although the cosmos is numerically grounded, the realm of space itself imposes limits on number. Accordingly, among perfect polygons one encounters three regular grids, five regular solids (also known as the Platonic solids, i.e. the tetrahedron, cube, octahedron, dodecahedron, and icosahedron), eight semi-regular grids, and thirteen semi-regular solids (Lundy 2010: 38). It is immediately evident that these four numbers (3, 5, 8 and 13) are interrelated: three plus five gives eight, and five plus eight gives thirteen. In its turn thirteen is the number of semi-regular polyhedra, also known as Archimedean solids. Although they have regular faces of more than one type, these solids all fit perfectly within a sphere, displaying tetrahedral, octahedral or icosahedral symmetry. They were rediscovered by Johannes Kepler, who described these three-dimensional shapes in his *Harmonices Mundi* (Sutton 2010: 162).

Due to its declared geometrical (or polydimensional) proclivity, the Pythagorean notion of number being the essence of all things pertains notably to sense-perceptible things, so that measurement likewise entails corporeal things. In this perspective, Oswald Spengler argues, 'The worked stone [of the sculptor] is only a something insofar as it has considered limits and measured form... Apart from this it is a chaos, something not yet actualised.' The opposite of the latter state is that of cosmos, being 'a harmonic order which includes each separate thing as a well-defined, comprehensible and present entity. The sum of such things constitutes neither more nor less than the whole world.' Therefore, Hellenic mathematics is fundamentally solid geometry (Spengler 1991: 46-47). The transition from chaos to cosmos is thus effected by the geometrical extension of number.

The Pythagorean doctrine that things resemble numbers also anticipates Plato's affirmation that sensible things resemble or imitate intelligible Forms. 'More generally,' as commented by Richard McKirahan (1994: 112), 'numbers, geometrical figures, the physical *kosmos*, and musical scales are generated similarly: all come to be when limit is imposed on the unlimited. All are instances of order, perhaps even of sequential order, which exists in different realms. And they all have numerical aspects that are basic: the number of sides of a triangle, the number and distances of the heavenly bodies, the ratios of the lengths of strings.' As we are taught in the Pythagorean *Golden Verses*, 'And thou shalt know that law... established the inner nature of all things alike' (quoted in Critchlow 2010: 5). This notion of a lawfully ordered cosmos is of lasting metaphysical significance.

Heraclitus taught that the cosmos is constituted by pairs of opposites that are continuously interacting. We read, for example, in Fragment 8 of the Ephesian thinker's work: 'What is opposed brings together; the finest harmony is composed of things at variance, and everything comes to be in accordance with strife'. However, due to the presence of the *logos*, the becoming and change that characterise the physical world do not occur in a chaotic manner:

‘all things come to be in accordance with this *logos*’ (Fragment 1). The manner in which the *logos* rules the cosmos is by determining the conflict between opposites, thereby providing a deeper unity and harmony underlying the changes flowing from the conflict. The *logos* is therefore the ground of all that exists, and it rules the cosmos through divine law. Thus for Heraclitus all things find their unity in the *logos*, while the *logos* manifests itself in the multiplicity of phenomena (Dreyer 1975: 42). The *logos* is therefore the mediator between the one and the many.

In a marked theological advance on polytheism, Heraclitus declared the *logos* to be the only God, with the entire cosmos standing under its law. As stated in Fragment 67, ‘God is day and night, winter and summer, war and peace, satiety and hunger, but changes the way [fire], when mingled with perfumes, is named according to the scent of each.’ In other words, the *logos* is the law of nature, determining all changes in the physical cosmos. In this way the *logos* provides the primeval rationality and order of the cosmos, so that God, nature and humans form a deep-lying unity (Dreyer 1975: 43). In addition, just as the cosmos has positive connotations of goodness and beauty, for Heraclitus the *logos* has rational connotations linking it with justice, law, and soul (McKirahan 1994: 142). This rational order of the cosmos is not only intelligible (at least in principle), but it is also intelligent ‘in the sense of the cosmos working itself out in accordance with rational principles’ (Curd 2011). The *kosmos* therefore displays rationality and intelligibility due to the activity of the *logos*.

Parmenides diverged from the monistic Ionian philosophy (i.e. the notion that the cosmos is derived from a single principle)[28] by postulating a basic duality in the phenomenal world. In the celebrated poem of the Eleatic thinker the following distinction is made: ‘For one, the aetherial fire of flame, mild, very light, the same as itself in every direction, but not the same as the other; but that other one, in itself is opposite – dark night, a dense and heavy body’ (Fragment 8). This reasoning implies that either everything in the phenomenal world is a compound of fire and night, or that the cosmos as a whole is full of these two elements (McKirahan 1994: 175-176). In terms of the basic Eleatic differentiation, the realm of becoming exists between being (*to on*) and non-being (*to me on*). Empirical phenomena are therefore real relative to non-being but unreal relative to being.

[28] Although we have shown in an earlier chapter that the ‘single principle’ of the Ionian philosophers also symbolises the universal Substance, or *Prakriti*, that underlies the world of phenomena. The ‘water’ of Thales and the ‘air’ of Anaximenes, for example, should therefore not be misunderstood in material terms only, as is mostly done in modern scholarly circles.

The relation between being and non-being may equally well be depicted in numerical terms. Although the number zero (or rather, the absence of number indicated by it) was unknown in Hellenic numerology, a symbol for zero was (independently) invented at least three times, namely by the Babylonians, the Mayans, and the Indians. Among the latter, the zero was associated with the void (*Sunya*), thereby denoting the (ultimately unknowable) abyss of non-being, which is simultaneously the pregnant ground of all being. Accordingly, both zero and one are situated on the borderline between absence and presence (Lundy 2010: 56). It is also of interest to note that the symbols for zero and one combine to form the so-called Golden Section, symbolised by the Greek letter Φ (*phi*). It represents the division of a line so that the ratio of the lesser part to the greater part is exactly the same as the ratio of the greater part to the whole. In numerical terms this division always produces either 0.618 or 1.618, ratios that often appear in organic life (Lundy 2010: 86).

From the extant fragments and testimonia it appears that Empedocles viewed the generation of animals as taking place in stages, which ought to be placed in the context of the cosmic interaction between Love and Strife (McKirahan 1994: 278). The process begins in a period of increasing Love, so that the elements are united into body parts, but the dominance of Strife prevents these parts from joining into animals: 'By her [Love] many neckless faces sprouted, and arms were wandering naked, bereft of shoulders, and eyes were roaming alone, in need of foreheads' (Fragment 57), and 'In this situation, the members were still single-limbed as the result of the separation caused by Strife, and they wandered about aiming at mixture with one another' (Fragment 58). In the second stage a greater intermixture of body parts becomes possible as Love's influence increases further: 'But when divinity was mixed to a greater extent with divinity, and these things began to fall together, however they chanced to meet, and many others besides them arose continuously' (Fragment 59). However, due to the presence of Strife this is still an apparently random process, resulting in monstrous combinations such as minotaurs and centaurs: 'Many came into being with faces and chests on both sides, man-faced ox-progeny, and some to the contrary rose up as ox-headed things with the form of men, compounded partly from men and partly from women, fitted with shadowy parts' (Fragment 61). Nevertheless, according to Empedocles in this latter stage limbs begin forming viable combinations, thus representing the beginning of the natural history of living animal species. Viability in this regard pertains not only to individual survival, but even more so to reproduction, which enables continuance of species without resorting to chance combinations. This perpetuation of species represents a further advance of Love (McKirahan 1994: 279). By postulating that viable combinations of limbs and organs survive while unsuitable combinations perish, Empedocles could be said to have held an early notion of natural selection and survival of the fittest (Swift 2002: 58). We also contend that Empedocles' reference to an 'appropriate formula' to which organisms have to comply in order to survive accords with the notion of lawfulness in the evolutionary process.

In the cosmology of Anaxagoras all things are with like parts (*homoiomereiai*) of each other, which implies that change entails the transmission of something that is already present. This insight would exercise a lasting influence in the metaphysics of causality, notably in biology (Blackburn 2008: 15). It is moreover relevant to the theory of evolution according to natural law, according to which life-forms unfold as determined by their inherent possibilities. For Anaxagoras the action of Mind (*nous*) in establishing the cosmos is not only of a mechanical nature, but also has an intellectual dimension. As stated in Fragment 12: 'And Mind rules all things that possess life – both the larger and the smaller... And Mind knew all the things that are being mixed together and separated off and separated apart. And Mind set in order all things, whatever kinds of things were to be – whatever were and all that are now and whatever will be.' In short, Mind rules all things, knows all things, and sets in order all things. Mind is not only omnipresent, but is also omnipotent and omniscient, since the cosmos is arranged by Mind according to its will. Since the things in the universe come to be and events occur in order to achieve a specific goal (McKirahan 1994: 221), the philosophy of Anaxagoras entails a teleological world-view rather than a mechanistic one.

We have already noted that the terms Spirit/*Atma* and Intellect/*Buddhi* are interrelated, so much so that from the viewpoint of manifested being they could be regarded as synonymous. Thus the Greek term *nous* (as used by Anaxagoras and also translated as Mind) embraces all that is meant by both spirit (Latin *spiritus*, Arabic *ruh*) and intellect (*intellectus*, *'aql*) in the Christian and Islamic traditions (Uzdavinys 2004: xv). This furthermore implies that the epistemological distinction between thought (*noēsis*) and discursive reason (*dianoia*) does not pertain to the relation between intellect and spirit, both of which indicate universality.

According to Diogenes, the entire world of physical phenomena arises from the intelligence (*noēsis*) underlying it. The term *noēsis* is related to *nous*, which is used by Anaxagoras for Mind. As we read in Fragment 5 of Diogenes' writings, 'that which possesses intelligence is what people call air, and all humans are governed by it and it rules all things. For in my opinion this very thing is god, and it reaches everything and arranges all things and is in everything. And there is no single thing which does not share in this.' Both *noēsis* and *nous* are conceived as an intelligent principle. The relation between things and intelligence in this conception has been explained by McKirahan (1994: 348): 'Even though not all things are intelligent, their ultimate material identity with thought (i.e. air) enables them to be affected by the intelligent ruler of the universe.' Like the early Ionians, Diogenes asserts that the eternal, immortal universal Substance is divine: 'And this very thing [i.e. intelligence] is an eternal and immortal body, and by means of it some things come to be and others pass away' (Fragment 7). In other words, divinity and intelligence and rule are intimately related, all of them being symbolised by the element of air.

7.3 Plato

The best-known ontological concept of Plato is that of the multiple Forms (or Ideas) that serve as models, or templates, for the world of phenomena. The wide-ranging scope of the Forms has been accurately summarised by Desmond Lee (1987: 266) in his translation of the *Republic*: 'Briefly therefore we may say that the forms are objects of knowledge (as opposed to opinion), are what is ultimately real (as opposed to what appears or seems), are standards or patterns to which different but similar particulars approximate, though imperfectly (this meaning is particularly relevant in morals and mathematics), and are the common factor in virtue of which we give groups of particular things a common name.' That is to say, the Forms entail epistemological, ontological, paradigmatic, and nomenclatural dimensions.

In the Platonic conception the Forms are both transcendent in relation to the sensible objects determined by them and immanent in these objects. Since sensible objects participate in the Forms, 'the creature possesses its own intelligible nature through actual participation in the creative cause which brought it into being' (Sherrard 2002: 6). Plato's notion of participation refutes the widely-held opinion that he advocated a rigid dualism of being and becoming, entailing the intelligible and sensible realms respectively. For Plato the sensible world is produced by the interaction between the principle of Form and formless matter. This cosmological conception does not imply an absolute duality between Form and matter, since the principle of Form (i.e. the Demiurge) is not absolute reality (which is the Good), but is rather a determination of the transcendent Good (Sherrard 2002: 6). We have noted how Plotinus developed this distinction into the first and second divine hypostases, namely the transcendent One and the creative Intellect respectively. In addition, Plato's formless matter (or space, *chora*) is not the substance out of which things are made (like the Aristotelian *hylē*, matter), but it precedes substance as the receptacle in which sensible things originate (Sherrard 2002: 6). This formless matter does not pre-exist like Aristotle's *hylē*, but originates and participates ('in a most perplexing way', as Plato admits) in the pre-formal reality from which the principle of Form derives (*Timaeus* 50c-51b). In this way both Form and formless matter originate in the supreme reality, which is the Good, or the One (Sherrard 2002: 6).

It has become customary to characterise Plato's philosophy as essentialist, due to his insistence on the primacy of being over becoming. According to Plato, the elements are constructed out of geometric figures by the Demiurge, and since living things are composed of the elements, they too have a mathematical grounding. This notion could be termed an elemental essentialism, as Lloyd Gerson suggested. However, Plato's essentialism differs from that of Aristotle with its distinction between essential and accidental change (Gerson 2005: 106-107). Aristotelian essentialism distinguishes between the properties of a thing or a kind that are essential to it, and those that are accidental. This implies that essential properties are those which cannot be lost without the thing or kind ceasing to exist (Blackburn 2008: 120). Plato's legacy in this regard would prevail for many centuries to come, to the extent that a leading Neo-Darwinian biologist, Ernst Mayr, could declare that essentialism came to dominate Western thought for more than two millenniums after Plato (O'Rourke 2004: 37).

In Plato's cosmology the Demiurge fashions the formless matter found in the receptacle of becoming into the geometrical figures of the tetrahedron for fire, the octahedron for air, the icosahedron for water, and the cube for earth (*Timaeus* 55e-56a). In his *Commentary on Timaeus,* Proclus provides an explanation for Plato's preference for geometrical figures. According to Pythagorean doctrine, reality is divided into three levels: the intelligible, the physical, and the intermediate. Since the latter is identical with the mathematical realm, Plato defines the properties of the soul on the basis of geometrical figures, and postulates that the causes of all things pre-exist primordially in the demiurgic Intellect (Dillon and Gerson 2004: 339-340). And because the physical universe is perceptible, we cannot have knowledge (*epistēmē*) of it, but only opinion (*doxa*). Plato therefore emphasised that his dialogue *Timaeus* is a 'likely account' of the cosmos and its creation. According to Plotinus, this statement affirms that the anthropomorphisms ascribed to the Demiurge, for example sowing or speaking, are not to be taken literally, particularly where these actions imply temporality

(*Enneads* IV, 8, 4; Dillon and Gerson 2004: 62). This argument represents an early objection to what in recent times has become known as literal creationism.

The creative role of the Demiurge represents an advance on Plato’s introduction of the Form of the Good in the *Republic*, as Donald Zeyl (2009) has argued. In that monumental dialogue, Forms other than the Good are presented as good on account of their perfect participation in the Good, while sensible objects are good on account of their participation in these Forms, albeit imperfectly. In the *Timaeus*, however, Plato acknowledges that order is not inherent in the sensible world, but needs to be imposed by Intellect as personified by the Demiurge, or divine Craftsman. Moreover, the ontological status of Intellect appears to be on the side of neither being nor becoming, which implies that Plato’s being/becoming distinction is not intended to be exhaustive. Therefore, ‘It is reasonable to conclude that Intellect is a *sui generis* substance that transcends the metaphysical dichotomy of being and becoming – possibly not unlike the Judeo-Christian conception of God’ (Zeyl 2009). It is also relevant to note in this regard that the literal meaning of *hylē* is wood, forest, or woodland, as opposed to *dendra*, meaning fruit trees. Generally speaking, *hylē* refers to the stuff of which a thing is made, in other words the raw material of any kind (L&S 725). This being the case, the transcendent power by which all things are made is necessarily depicted as an architect or a carpenter, as remarked by Ananda Coomaraswamy (1989: 82). The Platonic doctrine of a Divine Craftsman reflects this notion of a transcendent power shaping raw materials.

One of the most significant teleological consequences of Plato’s cosmology is that the sensible world displays intelligibility due to the presence of Intellect. In the *Philebus* we find Socrates positing two possible explanations for the existence of the cosmic order: either it is ruled by unreasoning chance, or it is governed by reason ‘and by the order of a wonderful intelligence’ (28d). Protarchus then affirms the latter view: ‘The only account that can do justice to the wonderful spectacle presented by the cosmic order of sun, moon, and stars and the revolution of the whole heaven, is that reason arranges it all’ (28e). That is to say, through the imposition of order onto the pre-existent chaos of the universe, the Demiurge establishes intelligibility in the cosmos. And since this cosmic ordering is brought about by means of mathematical figures and numbers, for Plato all that is intelligible in the sensible world is mathematically expressible – which should, however, not be misunderstood as viewing the sensible world as containing only that which is thus expressible (Gerson 2005: 215, 240). We have already noted Plato’s affirmation of the role of Necessity in opposing the works of

Intellect, thereby establishing both final and mechanistic causation in the cosmos.

7.4 Aristotle

Although Aristotle more or less agreed with Plato on the priority of form over matter, being over becoming, and soul over body, as well as on the reality of final causality (or teleology), the Stagyrite pupil differed from his Athenian mentor on the relation of the cosmos to time. For Plato, the universe is formed in time, being the handiwork of a divine Craftsman. For Aristotle, in contrast, time is infinite and the world is eternal (*Physics* VIII.251b; Swift 2002: 36, 37). Therefore, in the Aristotelian conception there is no requirement for a deliberate creation of the world, although the dependence of the physical world on an immaterial, formal principle is recognised – the latter being the Prime Mover, or God. Aristotle's view of God as both final and efficient cause of the cosmos has been outlined as follows by David Ross: 'The answer is that God is the efficient cause by being the final cause, but in no other way. Yet He is the final cause not in the sense of being something that never is but always is to be. He is an ever-living being whose influence radiates through the universe in such wise that everything that happens – at any rate if we leave out the obscure realms of chance and free-will – depends on Him' (1995: 186).

Aristotle's view of God as pure actuality (*Metaphysics* XII.1071b) has been related by Thomas Aquinas to the distinction between actual and potential being. In his *Quaestiones Disputatae de Potentia*, the Dominican scholar argued that 'A thing's power or potential (Latin *potentia*) is its openness to some act or actuality (*actus*), either the primary act of having form, or the secondary act of action..., because a thing's form of existence determines its activity and goal... To be acted on things must have passive potential, and to act they must have the primary act of form... So God, who is pure and primary act, must of all things be the most active spreading his likeness abroad, and so must of all things be the most powerful or actively potential source of activity' (McDermott 1993: 65-66). This reasoning implies that all things receive their existence due to the activity of God.

Another difference between Plato and Aristotle pertains to bio-philosophy. The notion of life as a cause or a principle is Platonic, while Aristotle wrote only about living beings, in terms of which life is a specific effect of the soul (Gilson 2009: 17). A distinction should also be made between the notions of vitalism and final causality. Vitalism understands life as the distinct energy proper to living beings, while final causality pertains to the organic purpose that indwells living beings (Gilson 2009: 143). Aristotle insisted that this principle of organisation inherent in animals and plants can only come from without. In the *Parts of Animals* he stated the case as follows: ‘For just as human creations are the products of art, so living products are manifestly the products of an analogous cause or principle, not external but internal, derived like the hot and the cold from the environing universe’ (I.641b).

A fundamental distinction is made by Aristotle between the natural and the artificial. Whereas natural things have their principle of movement within, with artificial things the source of movement is external (*Physics* II.192b). Building on this differentiation, the biochemist Michael Denton stated that the realm of the natural entails a finite number of forms, but an infinite number of paths toward actualisation. In contrast, the realm of the artificial entails an infinity of forms, but each is assembled by only a few or even one constructional path, as is the case with machines and watches (Denton 2002: 333). This implies that, as a natural phenomenon, the evolutionary process is based on a finite number of intelligible forms (*eidoi*), which are manifested in an almost infinite variety of morphological forms (*morphai*). It had earlier been suggested by Alfred Wallace that the infinite variety observed in nature can be traced back to the almost infinite complexity of the cells that constitute living beings, to the protoplasm which is the substance of the cells, of the elements that constitute the protoplasm, of the molecules of those elements, and finally of the atoms whose combinations form those molecules (Flannery 2011: 196-197).

Aristotle continued the Platonic dictum that form expresses all that is intelligible in nature. In contrast, matter is only an object of scientific knowledge by analogy, as bronze is to a statue or wood to a bed (*Physics* I.191a; Gerson 2005: 240). The combination of matter and form in the establishment of substance applies to the levels of the individual, the species, and the genus, as commented by Thomas Aquinas. Thus the matter and form of the same individual (say Cicero) are the same individually; the matter and form of different individuals of the same species (say Socrates and Plato) are the same in species but differ individually; and the bodies and souls of donkeys and horses, for example, differ in species but are the same generically (*On the Principles of Nature*; McDermott 1993: 79-80). In other words, Thomas writes elsewhere, form demarcates species within a genus, whereas matter demarcates individuals within a species (*On Being and Essence*; McDermott 1993: 98). This combined Aristotelian and Thomist argument also serves to affirm the reality of species, contrary to its denial by Darwin and some Neo-Darwinists.

In an elegantly reasoned passage in the *Physics*, Aristotle emphasises the continuity that is present in change: ‘Since everything that changes changes from something to something, *that which has changed must at the moment when it has first changed be in that to which it has changed*. For that which changes retires from or leaves that from which it changes: and leaving, if not identical with changing, is at any rate a consequence of it. And if leaving is a consequence of changing, having left is a consequence of having changed: *for there is a like relation between the two in each case*’ (VI.235b; italics ours). Elsewhere Aristotle argues along similar lines in terms of his metaphysics of potency and actuality: ‘Reflection confirms the observed fact; the actuality of any given thing can only be realised in what is already potentially that thing, i.e. in a matter of its own appropriate to it’ (*On the Soul* II.414a). In the case of living beings, therefore, an organism can only be actualised according to its potentiality. This view is clearly at odds with the Darwinian hypothesis that new species are formed due to material and mechanical factors only.

Aristotle’s notion of material causality is also relevant to his teleology. In the first place, matter resists form, and accordingly there is always tension between form and matter. This tension leads to imperfection, failure, chance, decay, and eventually substance losing its form (Dreyer 1975: 134). Secondly, real matter is formed matter, with limited possibilities. A particular matter is therefore only receptive to certain forms. However, there is also a positive side to material limitations, in that a particular matter has a natural inclination to assume certain forms. For example, stone and wood are naturally suited to become a house, Aristotle suggested. In other words, there is a natural purpose inherent in matter (Dreyer 1975: 135). For Aristotle both final and material causality should be considered in bio- philosophy, but the final cause constitutes the nature of an animal much more than does its matter (Gilson 2009: 125). It has been argued that for Aristotle the purpose (*telos*) of living beings does not arise from the physical order of nature (*physis*). Rather, *telos* signifies the limit of living beings, presiding from the beginning over the ordering of their parts, resulting in beauty and order being established (Gilson 2009: 19). However, for Aristotle the beauty of a living organism has nothing to do with utility, since beauty is an end in itself and not a means to something else (Gilson 2009: 24).

This Aristotelian notion of beauty as an end in itself has been evoked by Lord Northbourne in a delightful essay titled ‘Flowers.’ To begin with, it is noted that in the modern scientific view a flower is merely a mechanism for the transfer of pollen to another flower of the same species. The form, colour and fragrance of flowers are said to have been evolved to attract insects, which compensates for the immobility of plants. However, the British traditionalist mentions many species of flowering plants in which the size or brilliance of the flowers bears no relation to their attractiveness to insects. Instead, the phenomenon of floral beauty displays the underlying harmony of the created order, which is obscured by the existence of struggle. The latter, however, 'does not constitute the basic force that moulds the world of nature, still less did it produce the beauty of flowers, as is postulated in evolutionist theories.' It could therefore be declared with confidence that the beauty of flowers are neither accidental nor limited to functional or utilitarian purposes. Ultimately, 'each manifestation of floral beauty is in some degree unique and incomparable' (Northbourne 1995: 90, 93, 98).

The biological implications of Aristotle's insistence on both material and formal causality in the organic realm are lucidly depicted by Michael Tkacz: 'The form of organisms and the natural agencies that produce those forms can only be understood in relation to the material constitution of organisms. At the same time, the form of an organism cannot be reduced to its matter and the final optimal state of the organism cannot be reduced to the natural processes that bring it about. Organic morphology remains irreducibly formal while existing only in matter. Natural processes remain irreducibly teleological while remaining material processes. Aristotelians, then, agree with modern biologists on the importance of the underlying materials and mechanisms of organisms without at the same time accepting the reduction of the organism's reality to its material and biochemical mechanisms' (2013: 671-672).

Aristotle did not completely reject the mechanistic world-view postulated by Empedocles, but insisted that it could not provide a complete explanation of organic reality. As argued in *Parts of Animals*, 'Even Empedocles … finds himself constrained to speak of the reason (*logos*) as constituting the essence and real nature of things' (quoted in Gilson 2009: 125-6). In addition, Aristotle reasoned that we behold some of the divine attributes in the mechanical operations of nature (Thompson 1992: 9). The necessity of recognising both teleology and mechanism has been stated in the following elegant way: 'Still, all the while, like warp and woof, mechanism and teleology are interwoven together, and we must not cleave to the one nor despise the other; for their union is rooted in the very nature of totality' (Thompson 1992: 5).

The interaction between mechanism and teleology also relates to contingency. As remarked by

Etienne Gilson, mechanism can only offer chance as an explanation, yet chance is not a cause but simply an absence of explanation. Opposing the Darwinist notion that the whole evolutionary process is driven by chance, the French philosopher argues that 'whether the absence of a cause lasts a year or billions of years, it remains forever an absence of cause, which, as such, can neither produce nor explain anything' (1984: 154). Moreover, the notion of final causality is opposed to chance. For instance, the biologist Lucien Cuenot stated that one of the principles of finalist philosophy is its power of invention and organisation, which is anti-chance (Gilson 2009: 155-157).

With his teleological approach Aristotle opposed the notion of Empedocles that living bodies arise through chance events, arguing instead that they come into being through the seed of their parents which determine its products, namely the offspring (Gilson 2009: 8-9). In addition, although occasional deviations from formal causality do occur, they are chance events which cannot become part of the nature of the particular organism. Therefore, the kinds of animals are more or less constant within their forms (O'Rourke 2004: 25, 26). Evidently this view excludes the possibility of new species arising through a process of transformation, as is postulated in Darwinism. Moreover, as stated by Augustine in *On the True Religion*, natural things would not have forms that formed them unless there was a first source of their own formation. And the ultimate source of the forms, Thomas Aquinas notes, is God, who created the forms (*Quaestiones Disputatae de Potentia*, 3.7-8; McDermott 1993: 309).

It is a matter of fact that certain biological phenomena cannot be explained by mechanistic causation alone. A number of such cases have been pointed out by Terence Nichols, including morphogenesis, or the development of (physical) form in organisms; the regeneration of damaged organs in animals; and the ability of various organisms to regenerate themselves from parts. An example of the latter is the ability of flatworms to develop into complete animals when cut into pieces. None of these cases are explicable if formal causality is omitted, Nichols asserted (O'Rourke 2004: 30). Natural phenomena such as morphogenesis and regeneration therefore affirm the reality of formal causality.

Aristotle furthermore recognised the influence of the cosmos in the generation of living beings. As stated in the *Physics* (II.194), 'Man is begotten by man and by the sun as well.' And in the *Generation of Animals* Aristotle argues that the male is that which generates in another, while the female is that which generates in itself. Accordingly, Heaven and Sun are spoken of as begetters and fathers, and Earth as female and mother (Cornford 1997: 141). In other words, both heredity and the physical environment are involved in the production of offspring. It was suggested by Fran O'Rourke that this Aristotelian notion allows for the appearance of new animal forms under the combined operation of environmental changes and genetic mutations (2004: 40).

Aristotle's reference to human generation as due to both the parents and the sun could also be interpreted metaphysically. Ananda Coomaraswamy noted that a similar solar role in organic reproduction is encountered in traditional Indian philosophy (e.g. the *Satapatha Brahmana*) and in Dante's *Paradiso* (XXII:116 and XXIX:15). He writes, 'In all these contexts... the reference is, of course, to the "inward Sun" as distinguished from the "outward sun", which receives its power and lustre from the inward' (Coomaraswamy 1988: 106). This distinction between the invisible Sun (or Apollo) and the visible sun (or Helios) is made in the *Atharva Veda* and the *Brhadaranyaka Upanishad*, and by Plato, Plutarch, Philo of Alexandria and Jacob Boehme. With this Indo-Hellenic solar symbolism the causative role of the intelligible realm in the production of the sensible world is affirmed (Coomaraswamy 1988: 94, 106).

The solar symbolism employed by Aristotle pertains to his distinction between male and female as representing the formal and material principles in sexual reproduction (e.g. *Generation of Animals* I.729a-730b). This is also related to the distinction between the first and mediate causes of conception, as evoked in the *Jaiminiya Upanishad*, 'When the [human] father thus emits him as seed into the womb, it is really the Sun that emits him as seed into the womb', and in the *Brhadaranyaka Upanishad*, 'He who, present in the semen, whom the semen knoweth not... whose body the semen is,... the Immortal' (quoted in Coomaraswamy 1979: 94). That is to say, the intelligible Sun is the first cause and the male parent the mediate cause in the generation of animals. This Indo-Hellenic notion was affirmed in Christian terms by Thomas Aquinas when he wrote, 'The power of the soul, which is in the semen through the Spirit enclosed therein, fashions the body', so that ultimately 'the power of generation belongs to God' (*Summa Theologica* III:32.11; I:45.5; quoted in Coomaraswamy 1979: 94).

In his *History of Animals* Aristotle introduced the concept of species as natural kinds that reproduce true to their nature (Swift 2002: 59). This view anticipates the modern biological definition of a species as comprising all those organisms capable of producing fertile offspring. Moreover, with his notion that the male semen provides the formal principle in the generation of animals, Aristotle discovered the principle implied in DNA, Max Delbrück has suggested. Thus, 'The form [*sic*] principle is the information which is stored in the semen. After fertilization it is read out in a preprogrammed way; the readout alters the matter upon which it acts, but it does not alter the stored information, which is not, properly speaking, part of the finished product' (quoted in O'Rourke 2004: 12). Aristotle's view of reproduction as the impression of form by the male onto the matter provided by the female could be viewed as a biological version of the Indo-European notion that reality arises through the interaction between 'male' Essence (*Purusha*) and 'female' Substance (*Prakriti*), as the respective active and passive poles of universal Manifestation.

The Aristotelian scale of nature depicts reality as a graded development from the inanimate level through the vegetable and animal levels to the human level. As interpreted by Thomas Aquinas, this means that things on a higher level produce something in a more interior way than those on a lower level. The lowest level is that of non-living bodies, in which production only occurs when one body acts on another, for example fire producing fire. The next level above inaminate things is that of plants, in which a degree of interior production takes place, for example seeds. However, Thomas remarks, plant life is still imperfect, since what is produced inside ends up entirely outside, such as the process from flower through fruit to seed. The next level above plants is that of animals, in which sense-impressions come from the outside and ends up inside, by means of first imagination and then memory. Yet, Thomas adds, this level is still imperfect, since the production is always from one thing to another. The highest and most perfect level of life is that of the intellect, which is capable of self-reflection and self-understanding. This is itself divided into different levels: human, angelic, and divine (*Summa contra Gentiles*, 4.11; McDermott 1993: 115-116).

Considered in conjunction with Aristotle's doctrine on the serial order of souls, his scale of nature has been viewed by some modern thinkers, for example Joseph Needham, as anticipating the notion of evolution when a temporal dimension is added. However, the Darwinian conception of evolution in strictly material and external factors would undoubtedly have been rejected by Aristotle (O'Rourke 2004: 39, 41). In addition, although Aristotle recognised the existence of intermediate forms, no allowance was made in his hierarchy of being for evolutionary progression through transformism (Swift 2002: 60).

Aristotle stated that the order of actual development of things and the order of logical existence are always the inverse of each other (*Parts of Animals* II.646a). In other words, that which is posterior in the order of development is antecedent in the order of nature. Aristotle illustrates his argument by pointing to the fact that a house does not exist for the sake of bricks and stones, but these materials exist for the sake of the house. Therefore, 'In order of time, the material and the generative process must necessarily be anterior to the being that is generated; but in logical order the definitive character and form of each being precedes the material' (*Parts of Animals* II.646a-b). A similar distinction was made by Thomas Aquinas between the temporal process of generation and the completeness of being. Thus, 'Because activity in nature moves from the incomplete and unachieved to completeness and achievement, the unachieved is prior to the achieved in the temporal process of generation, though the achieved is is prior in completeness.' For instance, adults are prior to children in completeness of being, while children are prior to adults in the temporal process of generation (*On the Principles of Nature*; McDermott 1993: 75). This reasoning implies that the evolution of life from simpler to more complex forms does not refute the priority of form over matter.

The implications of Aristotle's scheme of causality for molecular biology has been deftly outlined by David Swift. Accordingly, the material cause of biological macromolecules is the constituent atoms, the formal cause is the proteins or genes, and the final cause is their roles in biological systems, such as to code for a protein or RNA, or to build a tissue. However, an efficient cause for biological macromolecules is lacking, since they cannot arise through a chance event or a progressive selective process (as postulated in the Neo-Darwinian model). Swift concludes, 'Biological macromolecules, in themselves, present a case for design for which we do not have a natural or scientific explanation; they point clearly to there having been a purposeful designer' (2002: 398-399). That is to say, the absence of efficient causality for biological macromolecules holds significant teleological implications

In the light of his theology and teleology, Aristotle viewed the cosmos as characterised by goodness, beauty, order and purposefulness (Dreyer 1975: 138). In addition, since the various animal structures are functionally well-suited, it follows that organisms had to be designed (Swift 2002: 60). Fran O'Rourke argued that Aristotle's teleology differs fundamentally from that of Plato in that the Stagyrite admits of no purposive, causal agent that transcends nature. Instead of a divine Craftsman implanting purpose in the cosmos, it is nature itself that is said to establish purpose by means of the form of the organism or structure. For instance, Aristotle wrote in the *Progression of Animals*, 'Nature makes nothing without a purpose but always with a view to the best possible for each individual, preserving the particular substance of each' (quoted in O'Rourke 2004: 19). On the other hand, it has been suggested that this personified conception of Nature, who aims at purpose and does nothing in vain, might be identified with Plato's Demiurge (Cornford 1997: 39). It appears that O'Rourke's attribution of a purely immanent purposefulness in nature to Aristotle is a reductionist argument.

For Thomas Aquinas the teleological dimension in nature served as one of the proofs for the existence of God. In the *Summa Theologiae* (at 1a.2), the Latin theologian argues as follows: 'Goal-directed behaviour is observed in all bodies in nature, even those lacking awareness; for we see their behaviour hardly ever varying and practically always turning out well, which shows they truly tend to goals and do not merely hit them by accident. But nothing lacking awareness can tend to a goal except it be directed by someone with awareness and understanding: arrows by archers, for example. So everything in nature is directed to its goal by someone with understanding, and this we call God' (McDermott 1993: 201-202).

The distinction between the Platonic and the Aristotelian teleology has been summarised as follows by Donald Zeyl: 'Aristotle's teleology is local, not global: while it makes sense to ask Aristotle for a teleological explanation of this or that feature of the natural world, it makes little sense to ask him for a teleological explanation of the world as a whole. Moreover, for Aristotle the development of an individual member of a species is determined by the form it has inherited from its (male) parent: the goal of the developing individual is to fully actualize that form. For Plato the primeval chaotic stuff of the universe has no inherent pre-existing form that governs some course of natural development toward the achievement of some goal, and so the explanatory cause of its orderliness must be external to any features that stuff may possess' (Zeyl 2009). Hence Plato's postulation of the Demiurge, which through Intellect persuades Necessity to co-operate in the formation of the cosmos out of chaos.

7.5 The Neoplatonists

According to Plotinus the cosmos is not the creation of a Deity, but is rather the self-expression of the World-Soul as it experiences the divine Intellect. Therefore God, or rather the One, cannot be held responsible for the evil that pervades the created order. Through contemplation of the Forms contained within the Intellect, the one Soul produces the many individual souls in the cosmos, thereby actualizing the possibilities that inhere in the Forms (Moore 2005). Stated in Aristotelian terms, the movement from the One to the many entails a motion from potency to actuality. The individual souls in turn provide form to matter, thereby establishing substances throughout the cosmos.

For Plotinus matter is at the furthest remove from the One and exists outside the realm of Being. Nevertheless, due to the presence of Soul in the sensible world, the latter displays a derived order (*doxa*) which is a pale reflection of the order (*logos*) in the intelligible realm. In fact, Plotinus reasons, the sensible matter in the cosmos is an image of the intelligible Matter existing within the Intellect (Moore 2001). Although the sensible world is only a shadowy image of the intelligible world, it is good and beautiful in so far as matter is governed by form, or body by Soul (Wikipedia: Neoplatonism). Consequently, Plotinus argued, ‘Ugliness is matter not conquered by form’ (*Enneads* I.8.5). In other words, beauty is found in sensible things due to their participation in the intelligible Forms. Another Neoplatonist thinker, Iamblichus, reasoned in his *Commentary on Philebus* that the three monads of beauty, proportion, and truth proceed from the Good, and constitute three ‘moments’ of the hypostasis of Intellect (Dillon and Gerson 2004: 257). This reasoning implies that the beauty and proportion in the organic world are due to the ongoing activity of the divine Intellect.

It was argued by the last major Neoplatonist philosopher, Proclus, that the relation between the One and the many also pertains to the distinction between a genus and its species. In terms thereof, ‘The genus is the “unique form” spread through many separate things and existing in each of them.’ Thus the genus pre-exists each of its species and is participated in by them and by the genus itself, Proclus continues. It is therefore incorrect to view a genus as a ‘whole of parts’; rather, ‘The species are the many forms different from one another but comprehended by one unique embracing form, which is the genus.’ Moreover, although the genus transcends the species, it also contains the causes of the species. ‘The realities existing prior to species are not identical with the characters that exist in the species by participation’, Proclus concludes (*Commentary on Parmenides* I.5; Dillon and Gerson 2004: 316). Biologically speaking, it could therefore be stated that species evolve out of their genus through participating in the pre-existent realities contained in the genus (e.g. lions, tigers and leopards as species of the genus *Panthera*). The same argument applies to genera participating in their family (e.g. *Felidae*), families in their order (e.g. *Carnivora*), orders in their class (e.g. *Mammalia*), and classes in their phylum (e.g. *Chordata*).

As culmination of the Platonic tradition in the Hellenic world, the Neoplatonists inherited the

Presocratic notion of cosmic unity. This implies that the constituents of the world and the laws according to which it operates are interrelated as well as intelligible. Moreover, for the Neoplatonists the unity of the world enables a systematic understanding thereof (Gerson 2005: 32). In other words, the notion of the intelligibility of the cosmos entails a recognition of natural laws; therefore the physical world, including the organic, is lawfully constituted.

7.6 The Great Chain of Being

The metaphysical notion of graded continuity between various levels of being, all of it originating in the divine Principle, is encountered in both Indian and Hellenic philosophy. For instance, the *Rig Veda* declares: ‘Thrice Vishnu paced and set his step uplifted out of the primal dust; three steps he has paced, the Guardian, the Invincible, and from beyond he upholds their laws’ (I.22). According to Aurobindo, the Vedic text here refers to the triple world of mind, life, and matter, which in reality is one Energy triply formulated. That is to say, matter is energy in action, and energy is consciousness in action (Van Vrekhem 2012: 90, 266). One could add that the *Rig Veda* herewith also affirms the reality of natural laws and their foundation in the divine creative act.

In the Western world the notion of levels of being is first encountered in the work of Homer, who mentions a Golden Chain (*seire chruseie*) stretching from heaven to earth (*Iliad* VIII.18; Uzdavinys 2004: xxi). This was also expressed by Plato with his tripartite division of the human soul into desire, sensitive and rational souls, centered at the navel, heart, and head, respectively (Van Vrekhem 2012: 90). The chain of being was applied for the first time to the organic realm in Aristotle’s scale of nature, ranging from the Prime Mover all the way down to unformed matter. The Neoplatonists elaborated the teachings of Plato and Aristotle to postulate an all-embracing hierarchy of existent things ranging from inanimate matter through plants, animals, humans and heavenly beings (gods/angels) to God at the summit.

The Greek Patristic theologians similarly held an all-embracing view of being (*ousia*) and nature (*physis*), entailing the whole of the created order. One of the seminal figures in this tradition is Dionysius the Areopagite, who declared in the *Divine Names* that the Good is the source of all that exists: ‘It sends the rays of its undivided goodness to everything with the capacity, such as this may be, to receive it’ (4.1). On the highest level exist the intelligible, immaterial heavenly beings (i.e. the angels); next are the rational souls of humans, which have the potential to strive after the angelic life of intelligence and immortality; on the next level is found the irrational souls of animals, then the life of plants, and finally inanimate matter. All these levels of being, Dionysius asserts, receive their existence from the Good (4.1, 4.2). In this way the Pre-existent is the cause and source of all eternity, all time, and every kind of being. Everything participates in this Being that precedes all participating entities (5.5).

Moreover, Dionysius reasons, the divine Wisdom creates the differentiated unity of the cosmos. ‘It is the cause of the unbreakable accommodation and order of all things and is forever linking the goals of one set of things with the sources of another and in this fashion it makes a thing of beauty of the unity and the harmony of the whole’ (*Divine Names*, 7.3). This passage is summarised by Thomas Aquinas as stating, ‘God’s wisdom joins the ends of one domain to the beginnings of the next’ (*Summa contra Gentiles*, 3.97-98; McDermott 1993: 271). The graded continuity of the cosmic hierarchy is thus affirmed by two eminent Christian thinkers representing the same metaphysical tradition, one writing in Greek and one in Latin.

This all-embracing, graded ontology became influential in both the Christian and Islamic worlds of the so-called Middle Ages.[29] Working at the Carolingian court in the ninth century, John Scottus Eriugena described the whole of reality, from God to matter, in his monumental *Periphyseon*. The Irish scholar argued that God creates the cosmos through a five-fold process, out of the pre-ontological nothingness (Greek *ouk on*, Latin *nihil*) through the primordial causes (Latin *causae primordiales*, similar to the Platonic Ideas) which are contained in the divine Logos. This creative activity results in the establishment of various levels of being: natural bodies (e.g. rocks) are created for existence only; plants for existence as well as life; irrational animals for existence, life and sensation; human beings for existence, life, sensation and reason; and finally, heavenly beings (e.g. angels) for existence, life, sensation, reason and intellect (*Periphyseon* II, 580; Carabine 2000: 56). In this way each level of being obtains its own characteristic element, while also sharing in those below it.

In his *Summa contra Gentiles*, the thirteenth-century Latin theologian Thomas Aquinas related the doctrine of divine providence to the ordered variety of the world. Since all created things fall short of the full goodness of God, Thomas reasons, there had to be variety in things

[29] We say so-called, since according to the Organic cultural model postulated by Oswald Spengler, Francis Parker Yockey and other thinkers, each High Culture (e.g. Indian, Classical, Arabic, and Western) passes through its own phases of birth, growth, maturity, old age and death. Notions such as ‘ancient’, ‘medieval’ and ‘modern’ are therefore quite relative, in addition to ideologically serving an Occidental view of history. However, for the sake of convenience we will continue to use the adjective ‘modern’ when referring to the Western world of the past few centuries, in which sense it also means ‘anti-traditional.’

in order to express (partial) perfection in various ways: ‘for the perfect goodness that exists one and unbroken in God can exist in creatures only in a multitude of fragmented ways. Now variety in things comes from the different forms determining their species. So because of their goal things differ in form. And because they differ in form there is an order among things. By dint of having form a thing exists, and by existing it resembles God, who is his own existence pure and simple; so form can be nothing else than God’s resemblance in things’ (3.97-98; McDermott 1993: 271). This reasoning evokes the metaphysical principle of differentiated unity, or the One-in-many.

Thomas adds that this ordered variety of forms in nature harbours a number of implications. First, there has to be levels of being, since forms differ by degree of perfection. Thus the variety of things is achieved in steps, from inanimate matter through plants and unreasoning animals to intelligent creatures. Second, the diversity of form in different species actualises different behaviour, and therefore things differing in form act in different ways. Third, the variety of forms entails different relationships to matter. Whereas some forms can exist by themselves due to their degree of perfection, others need matter as a sort of base. And matter and form cannot combine without some proportion between them, so that different materials match different forms. These diverse relationships to matter produce a diversity of agencies, while the combined diversity of form, matter and agency brings about a diversity of characteristic and incidental properties (*Summa contra Gentiles*, 3.97-98; McDermott 1993: 271-272). In this way is the chain of being cast in terms of the Aristotelian metaphysics of form and matter, itself based on the Platonic ontology.

In an increasingly secularised Western world the chain of being was still widely known as late as the eighteenth century. As a matter fact, the Hellenic principles of plenitude, continuity, and gradation found their widest acceptance at precisely this time (Lovejoy 1960: 183). The Swedish botanist Carl Linnaeus applied the chain of being in his binomial system of biological classification, published as *Systema Naturae* in 1735. This assigned both a generic and specific name to thousands of animal and plant species, and still forms the basis of modern taxonomy. However, Linnaeus diverged from the traditional view by postulating a class of primates, consisting not only of monkeys and apes but also human beings (Van Vrekhem 2012: 16-17). In another work published only after his death, Linnaeus referred to the apes as the nearest relatives of humankind (Lovejoy 1960: 234). It is nevertheless noteworthy that the Swedish naturalist also drew inspiration from the Biblical reference to

Adam naming all the creatures in the Garden of Eden, according to God's command. As explained by Steve Fuller, 'In Linnaeus' case, however, the two-name system applied uniformly across the three kingdoms - of animals, plants and minerals - reflected the idea that Adam's exercise was informed by a *logos* emanating from God that identified a function corresponding to each species as part of an overall plan' (2008: 63).

However, during the eighteenth century the chain of being became temporalised in much of European thought. The principle of plenitude came to be viewed as applying to the entire temporal span of the cosmos, so that its possibilites are actualised in nature gradually and extremely slowly (Lovejoy 1960: 244). Thus the chain of being became conceived as 'a process of development in time, materialized in the gradually increasing complexity of the organisms on Earth' (Van Vrekhem 2012: 95). It was in this temporalised and materialised version that the notion of a chain of being contributed to the rise of evolutionary thought in its modern, horizontal form. The notion of evolution became a central idea of nineteenth-century Western thought, Francis Yockey remarked. Thinkers as disparate as Schopenhauer, Proudhon, Marx, Wagner, Nietzsche, Mill, Ibsen and Shaw were representatives of this trend. They differed only in their explanations of the purpose and mechanism of evolution, not in their acceptance of evolution (Yockey 1962: 68). The divergence hereof from an earlier view of evolution has been commented on by Oswald Spengler. For the thinkers of the nineteenth century, 'evolution' meant progress in the sense of increasing fitness of life towards purposes. In contrast, Leibniz and Goethe understood evolution as 'fulfilment in the sense of increasing connotation of the form' (Spengler 1991: 231). Their notion of evolution clearly approaches the classical Hellenic understanding far more so than that of the nineteenth century.

After the metaphysical tradition had become all but forgotten in the West due to the destructive rise of rationalism and materialism, not to mention the 'progress' mythology, major aspects of the traditional Hellenic ontology were restated by Arthur Lovejoy in *The Great Chain of Being*, first published in 1936. In this epochal work the author drew together three 'unit ideas' obtained from Plato and Aristotle: plenitude, continuity, and gradation (Bynum 1975: 4). The principle of plenitude (from the Greek *plērēs*, meaning 'full of', hence full, complete, or sufficient; L&S 565) derives from Plato, notably his dialogues *Republic* and *Timaeus*. It implies that the range of conceivable diversity of kinds of living things is abundantly exemplified in the universe; that no genuine potentiality of being can remain unactualised; and that the extent and abundance of life-forms must match the possibility of existence, commensurate with the productive capacity of an inexhaustible Source (Lovejoy 1960: 52). Nonetheless, the notion of fullness (or plenitude), should not be confused with perfection, Lovejoy cautions. Instead, ‘The principle of plenitude is rather the principle of the necessity of imperfection in all its possible degrees’ (1960: 338).

Although Aristotle rejected the necessary actualisation of all potentalities in the *Metaphysics* (III.1003a), his notion of continuity was logically implied by the Platonic principle of plenitude and eventually became fused with it (Lovejoy 1960: 55). Aristotle affirmed the reality of the continuous in the *Metaphysics* (XI.1069a) and its necessary divisibility in the *Physics* (V.231a). Moreover, he applied the principle of continuity to the organic realm by recognising the existence of continuous transitions from the inanimate to the animate, and from plants to animals (*History of Animals* VIII. 588b). Lovejoy concludes, ‘From the Platonic principle of plenitude the principle of continuity could be directly deduced. If there is between two given natural species a theoretically possible intermediate type, that type must be realized..., otherwise, there would be gaps in the universe, the creation would not be as “full” as it might be’ (1960: 58). The third Hellenic ‘unit idea’ is the principle of gradation, expressed by Aristotle as a scale of nature based on the degree of perfection, thus ranging from zoophytes to humans (*Generation of Animals* II.732a-733b). This notion of unilinear gradation was composed of ontological, zoological and psychological hierarchies, thereby postulating the conception of the universe as a Great Chain of Being (Lovejoy 1960: 59).

Eventually these Platonic and Aristotelian ideas became organised into a coherent system in the Neoplatonic theory of emanation (Lovejoy 1960: 59, 61). In the *Enneads* Plotinus reasons that the organic realm comes to be on account of Soul generating a reflection of itself, namely sense-perception and the principle of growth (V.2.1). As a result, the organic realm appears ‘like a long line stretched out in length, each of the parts other than those that come next, all continuous with itself, but one being different from the other, the first not being destroyed with the [appearance of] the second’ (V.2.2; Dillon and Gerson 2004: 85-86). And since the generation of these levels of being (plants and animals) is a logical necessity, Plotinus regards phenomena such as inequality, imperfection, and suffering as necessary for the good of the whole (Lovejoy 1960: 64-65). For instance, Plotinus denies that the existence of inequalities is due to the divine Will (as is taught in both Christian and Islamic theology), instead affirming it as necessary according to the nature of things (*Enneads* III.3.3).

Remarkably, even after the apparent victory of Neo-Darwinism over alternative theories of evolution by the middle of the twentieth century, there were still Western thinkers inspired by the chain of being in their writings. Prominent among them was Ernst Schumacher, who in his celebrated work *A Guide for the Perplexed* (1977) depicted an ascending hierarchical order of minerals, plants, animals, and humans. Parallel to these four ‘kingdoms’ are four characteristic elements, namely matter, life, consciousness, and self-awareness (Van Vrekhem 2012: 97). By stating that each ontological level possesses its own characteristic element while also sharing those of the levels below, Schumacher evoked the similar suggestion made by Eriugena in the previous millennium, as we noted above. The German economist further maintained that the levels of being are inexplicable mysteries, with ontological discontinuities between them. Moreover, since physics deals only with the lowest level, i.e. matter, it cannot make any impact on philosophy (Van Vrekhem 2012: 97-98). Undoubtedly, Plato would have agreed with Schumacher’s subordination of physics to philosophy.

Among more recent scientists, Paul Davies has defended the notion of a structural hierarchy in nature which cannot be explained in material terms only. In his *God and the New Physics* (1984), the English physicist argues that holistic concepts such as life, organisation and mind cannot be reduced to the actions of atoms, quarks or unified forces. In an admirable disregard of the prescribed divorce of physics from metaphysics that the modern scientific project has insisted on for hundreds of years, Davies writes that ‘Life is a holistic concept, the reductionist perspective revealing only inaminate atoms within us. Similarly mind is a holistic concept, at the next level of description. We can no more understand mind by reference to brain cells than we can understand cells by reference to their atomic constituents’ (quoted in Van Vrekhem 2012: 100). In other words, the ontological discontinuities from matter to life, and from life to mind, cannot be explained by reducing it to material and mechanical factors.

Finally, it is relevant to note that the metaphysical notion of a cosmic chain of being does not necessarily imply a rigid hierarchical system. Applying insights obtained primarily from Frithjof Schuon, James Cutsinger reasons with admirable bio-friendliness that ‘While plants may in general be “higher” than minerals, because of the organic life that is in them, a precious gem remains a more lucid theophany than a weed. The same qualification must be applied to the relative positions in the great chain of being of plants and animals, and of animals and man. A noble animal, like an eagle or a lion, is “more Divine” than a human being who lives below himself’ (Cutsinger 2007: 24). This reference to humans living below themselves reminds one of Nietzsche’s words at the beginning of *Thus Spoke Zarathustra*, when the eponymous hero made his first speech in the market-place after descending from his mountainous abode: ‘You have made your way from worm to man, and much in you is still worm. Once you were apes, and even now man is more of an ape than any ape’ (*Prologue*, 4). And by living below themselves, humans are failing in their divine calling to become like God, as was taught by the Greek Patristic theologians. In the words of Basil, Archbishop of Caesarea in the fourth century, ‘God created man like an animal who has received the order to become God’ (Lossky 1978: 73). Or in metaphysical terms, ‘it is Man’s return to the pole of Essence, the *imago dei* [image of God] which dwells within the spiritual Heart, by virtue of his ascent along the ontological ladder of his own being’ (Upton 2008: 193). Situated midway between the heavenly beings and the animals on the chain of being, human beings have the freedom to choose whether to orientate themselves upward towards God or downward towards the apes.

8: Form and transformation

8.1 Introduction

In earlier chapters we touched upon the numerical and geometrical foundations of the cosmos, as outlined by Pythagoras, Plato and Iamblichus. The process of cosmic manifestation entails an unfolding from numbers into lines (the point becoming one-dimensional), from lines into planes (the line becoming two-dimensional), and from planes into solids (the plane becoming three-dimensional). That is to say, the movement from the One into the many proceeds in the following sequence: numbers → lines → geometrical figures → solid bodies, according to the patterns of the immutable Forms. Moreover, the phenomenon of organic form cannot be conceived in material terms alone, since form is prior to matter (Plato), which in the case of living beings entails the priority of soul over body (Aristotle).

The metaphysical and physical significance of the Pythagorean sacred number, the *Tetraktys* (i.e. 1+2+3+4), has been sketched as follows by Miranda Lundy. The One, or the monad, 'is the limit of all, first before the beginning and last after the end, *alpha* and *omega*, the mold that shapes all things and the one thing shaped by all molds, the origin from which the universe emerges, the universe itself, and the centre to which it returns. It is point, seed, and destination' (Lundy 2010: 12). It should be kept in mind that all these terms are symbolical, since in reality the One is an ineffable mystery. Two is the dyad, viewed by the Pythagoreans as an even and female number, serving as the basis of all the pairs of opposites in the cosmos (e.g. limited-unlimited, one-many, male-female). The dyad also appears in music (the ratio 2:1, i.e. the octave); in linguistics (the prefixes bi- and di-); and as the Sun and Moon under which we live. Three is the triad, which serves as mediator between opposites, thus returning them to unity. The triad manifests in time as past, present, and future; in geometry as the triangle, which is the first stable polygon; and in the musical ratios 3:2 and 3:1, i.e. the fifth and its octave. Four is the tetrad, which is the first number in the realm of manifestation. It symbolises the Earth and the natural world. The tetrad appears in geometry as the simplest solid figure, the tetrahedron; as the material elements of fire, air, earth, and water; in music as the ratios 4:3 and 4:1, the fourth and two octaves; and in the particles of which all material things consist, namely protons, neutrons, electrons, and neutrinos (Lundy 2010: 14-18).

8.2 Organic form

In the traditional Hellenic understanding, the number five (the pentad, symbolising water) is associated with biological life, beginning with water. As described by Miranda Lundy, ‘Water itself is an amazing liquid crystal lattice of flexing icosahedra, these being one of the five Platonic solids, five triangles meeting at each point. As such, water shows its quality as being that of flow, dynamism, and life’ (2010: 20). Iamblichus affirmed that the lowest level of organic life is that of plants, represented by the pentad. The general structure of plants is five-fold: root, stem, bark, leaf, and fruit. While the first four numbers entail the generation of bodies up to three dimensions, the pentad entails change in respect of addition and increase, i.e. organic growth. It thus represents the vegetative aspect of the soul. The five sense-organs found in the higher animals are related to the five general elements, including ether (Waterfield 1988: 67-68, 73). The number five is represented by the pentagram, which is an image of the human being. It also indicates the elements of earth, fire, air, and water as modalities of the central element, ether; and it signifies the mental faculties of reason, intuition, imagination, and memory as emanating from the Intellect (Schuon 1981: 74). In some traditions this is symbolised by the five-petalled rose in the centre of the cross, denoting the unmanifested quintessence (Latin *quinta essentia*) which is the central principle of the four manifested elements (Northbourne 1995: 97).

Continuing the Pythagorean and Platonic understanding of number, we encounter six, the hexad, in crystalline structures such as snowflakes, quartz, and graphite; in the hexagons of carbon atoms that form the basis of all organic chemistry; in the hexapodal locomotion of insects; and in the hexagonal honeycombs of bees. The number seven, the heptad, appears in the colours of the rainbow; in the days of the week, of which each is connected with a specific planet and metal; and in the groups of crystal structures (Lundy 2010: 22-24). The first cubic number after one, the octad (2x2x2=8), manifests geometrically as the octagon, which indicates the link between Heaven (circle) and Earth (cube). The spatial perfection of the number eight is displayed in nuclear physics, where atoms ‘desire’ to have a full octave of eight electrons in their outermost shell. For instance, a sulphur atom has six electrons in its outermost shell, and therefore eight atoms join to share electrons, thus forming an octagonal sulphur ring (Lundy 2010: 26). It was remarked by Iamblichus that in the organic realm the octad is manifested in the number of feet of arachnids and crustaceans (although the Neoplatonist thinker erred regarding the latter, which are actually decapods using the first pair of feet as pincers); in the arrangement of human teeth as four quadrants of eight teeth each; and in the apertures of the mammalian head, namely pairs of eyes, ears and nostrils, and channels for air and food through the mouth (Waterfield 1988: 102).

The number nine, the ennead, is the celestial number of order, being the square of the triad. It manifests as the sum of the regular three-dimensional shapes, namely the five Platonic solids and the four stellar Kepler-Poinsot polyhedra; the nine planets of our solar system; the cross-section of the tentacle-like cilia on our internal surfaces; and the bundles of microtubes in centrioles, which are essential for cell division. It is also noteworthy that the geometrical expression of ten, the decagon, is formed from two pentagons. And since five is the number associated with water and organic life, it is particularly apt that DNA, the biochemical key to the reproduction of life, has ten steps for each turn of its double helix, which appears in cross-section as a tenfold rosette (Lundy 2010: 28-30).

We have already remarked on the relation between the numbers 5, 8, and 13 as encountered in two- and three-dimensional geometry. These numbers also occur in the Fibonacci sequence of 1, 1, 2, 3, 5, 8, 13, 21, 34, 55 and so forth, in which each number from 2 onwards is the sum of the preceding two numbers. It is significant that most of the plants on Earth produce alternate leaves at Fibonacci fractions of a full rotation. The study of this phenomenon is called phyllotaxis, from the Greek *phyllas* (leaf) and *taxis* (rank, order). As explained by John Martineau, ‘Some plants produce leaves along a stem every 1/2 rotation, in hazel and beech trees the angle is 1/3, in apricot and oak trees it is 2/5, in pear and poplar trees it is 3/8, and in almond and willow trees it is 5/13’ (2010: 324). In addition, pineapples display 5-, 8- and 13-armed spirals (viewed near-horizontal, at 45° and vertical, respectively), and a willow sprig displays 13 buds in 5 turns. That this remarkable phenomenon is not only lawful but also purposeful, may be discerned from the suggestion by Leonardo da Vinci that phyllotaxis optimises the access of plants to sunlight and dew (Martineau 2010: 324-325). In other words, organic functionality is optimised by conformity to the underlying form (*eidos*).

For Plato the order of nature is mathematical, or, to be more precise, geometrical (as described in the *Timaeus*). Therefore, since the laws of nature can be described in mathematical forms, nature is inherently intelligible. Aristotle similarly recognised the correspondence between the human mind and the natural world, for example his association (in the *Metaphysics*) of the sense of sight with our knowledge of the world (Denton 1998: 240, 392). Applying the principles of both Hellenic metaphysics and Newtonian physics to the organic realm in his work *On Growth and Form*,[30] the biologist and mathematician D'Arcy Wentworth Thompson argued that both the forms of natural phenomena (sea, clouds, etc.) and the material forms of living things (cell and tissue, shell and bone, leaf and flower, etc.) obey the laws of physics, thereby confirming that God is always geometrising. The latter statement is found in Plutarch (*Symposium*, viii.2), writing 'how Plato said that God is always land-measuring' (*pōs Platōn elege ton theon aei geōmetrein*). Consequently, the problems of forms are primarily mathematical problems, while their problems of growth are essentially physical problems. In this way morphology is interwoven with physical science (Thompson 1992: 7-8, 269).

It should be noted that throughout this epochal work Thompson appears to conceive 'form' in the sense of *morphē* (sensible shape) rather than *eidos* (intelligible structure). Given his interweaving of organic form with physical forces, it is not surprising that the Scottish scientist strove to explain embryological development in terms of physical causes instead of positing phylogenetic explanations. For this Thompson was ridiculed by Ernst Häckel and other Darwinists – a reaction which has over the past century become typical of the intellectual intolerance displayed towards scientists attempting to explain biological phenomena in non-evolutionary terms (Bakar 2003: 176). Nonetheless, the Hellenic notion of cosmic lawfulness is affirmed by Thompson when he states that in general no organic forms exist without conformity to physical and mathematical laws. In addition, the phenomenon of growth should be studied in relation to form, whether as increase in size or gradual change of form (Thompson 1992: 10). This recognition of physical and mathematical laws in nature does not entail a static view of the organic world, but rather a dynamic one. Thus the form of any portion of matter, and the changes of form that appear in its movements and growth, are due to the actions of force. Accordingly, in the case of organisms the nature of motions is interpreted in terms of force, i.e. kinetics, whereas the conformation of the organism itself is interpreted in terms of the balance of forces, i.e. statics. Morphology therefore deals not only with the study of material things and their forms, but also the operations of energy, or dynamics (Thompson 1992: 10-11, 14).

That variation and inheritance cannot be reduced to material causes is affirmed by the

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30 In this epochal work, written during the First World War and expanded during the Second, the author's magisterial grasp of not only zoology but also the classics and mathematics is evident from the seamless integration of these seemingly disparate disciplines into a tome that has been referred to as the finest work of scientific literature in the English language (Stephen Jay Gould, *Foreword* to the Abridged Edition, 1992).

following statement by Thompson: 'Matter as such produces nothing, changes nothing, does nothing; and… we must most carefully realise in the outset that the spermatozoon, the nucleus, the chromosomes or the germ-plasma can never *act* as matter alone, but only as seats of energy and as centres of force' (1992: 14). In this way, Thompson adds, is expressed in modern scientific terms the Hellenic philosophical dictum, *arkhē gar he physis mallon tes hylēs* – 'for nature is very much the beginning of matter' (1992: 14). It also evokes the crucially important Hellenic doctrine on the priority of form over matter, according to which unformed matter exists as a pure potentiality, until its actualisation by form.

We encounter a widespread instance of mathematical lawfulness in the plant kingdom, with botanical shapes that can be accurately depicted in terms of sine curves. The latter, also known as sine waves, are used to depict smooth, repetitive oscillations. Among plants it pertains to the following types: (a) reniform (i.e. kidney-shaped) leaves, as in the ground-ivy and dog-violet; (b) pentamerous (i.e. five-petalled) flowers; and (c) composites of (a) and (b), as in the horse-chestnut leaf with its five petal-like leaflets (Thompson 1992: 282-284).

8.3 Theory of transformations

Succinctly stated, morphology is the study of organic form. It is relatively easy, Thompson asserts, to pass from the mathematical concept of form in its static aspect to form in its dynamic relations, since these can be represented by a diagram of forces in equilibrium and the direction of forces which have effected the conversion of one form into another (Thompson 1992: 269-270). Furthermore, although there are organic forms that cannot be described mathematically, there are still enough instances to enable one to keep the type in mind and leave the single, accidental cases alone. It is also interesting that in the mathematical Theory of Groups a distinction is made between substitution and transformation, being discontinuous and continuous respectively. As Thompson remarks, this is curiously analogous to the biological distinction between mutation and variation (1992: 270-271).

The theory of transformations postulated by Thompson is based on the method of co-ordinates conceived by Descartes, which enables us to translate the form of a curve into numbers and words. Of particular interest to evolutionary biology is the deformation of a system of co-ordinates – that is, to enquire whether two different but more or less related organic forms can be shown to be transformed representations of each other, and from there to postulate the direction and magnitude of forces capable of effecting such a transformation (Thompson

1992: 271-272). Since the living body is an integral and indivisible whole, these co-ordinate diagrams should deal with organisms in their integral solidarity. Moreover, if dissimilar fishes, for example, can be referred to identical functions of different co-ordinate systems, then it will constitute proof 'that variation has proceeded on definite and orderly lines, that a comprehensive "law of growth" has pervaded the whole structure in its entirety, and that some more or less simple and recognisable system of forces has been in control' (Thompson 1992: 275). This argument supports the notion of lawful, directed evolution that we propose.

The geometrical basis of Cartesian transformations is that a circle inscribed in a net of rectangular equidistant co-ordinates (with horizontal axis x and vertical axis y), can be elongated into an ellipse by decreasing the length of one axis. For example, the metacarpal or cannon-bone of an ox, a sheep, and a giraffe differ widely in size, but all are transformations of a basic type with an elongation along the vertical axis, in the ratio 3:2:1 (Thompson 1992: 276-277). In its turn, radial co-ordinates are applicable especially to organisms of which the growing structure includes a 'node', i.e. a point where growth is absent or at a minimum, while around it the rate of growth increases symmetrically. This phenomenon occurs notably in the leaves of dicotyledon plants. For example, the begonia leaf represents a case of unequal but not truly asymmetrical growth on either side of the midrib (Thompson 1992: 278, 280).

A number of special cases of lawful organic transformation are also presented by Thompson. For instance, one encounters the transformation of a circle or sphere into two circles or spheres in the case of a small round gourd growing into a large round or oval pumpkin or melon. However, if a rag is tied around the middle of the gourd, it grows into two connected globes. Thompson concludes, 'It is clear, I think, that we may account for many ordinary biological processes of development or transformation of form by the existence of trammels or lines of constraint, which limit and determine the action of the expansive forces of growth that would otherwise be uniform and symmetrical' (Thompson 1992: 286-287). In other words, the existence of constraints on organic transformation has to be recognised.

An interesting analogy is found between the operations of a glass-blower and those of nature, evoking Aristotle's differentiation between the natural and the artificial. This parallel was first demonstrated by Oliver Holmes in his work *Elsie Venner*, in terms of which both nature and the glass-blower start with a simple tube. Thus in nature the alimentary canal, the arterial system (including the heart), and the central nervous system of vertebrae (including the brain), all begin as simple tubular structures. Moreover, Thompson remarks, the handiwork of the glass-blower is an example of mathematical beauty (1992: 287).

8.3.1 Rectangular co-ordinates

In his works *Geometry* and *Treatise on Proportion*, Albrecht Dürer described the transformation of human physical features by means of slight variations in the relative magnitude of the component parts. Dürer's illustrations inspired Peter Camper's notion of facial angles, the variety of which can be represented by both rectangular and oblique co-ordinates, as had indeed been done by Dürer. This geometrical depiction of human facial angles recognises the essential fact that the skull varies as a whole, and that the 'facial angle' is the index to a general deformation (Thompson 1992: 290-292).

Surveying transformation among the Crustacea (an invertebrate subphylum containing 42 000 species, found in every marine and freshwater niche; Cooke *et al* 2008: 546), Thompson demonstrates that the ostensibly immense difference between the elongated body of *Oithona nana* and the thick-set body of the genus *Sapphirina* (sea sapphires), entails nothing more than a difference of relative magnitudes, which can be expressed by means of rectilinear co-ordinates. And in the case of crabs, the large variety of shapes of the carapace can all be represented by means of either equidistant rectangular co-ordinates and its elongation and compression, or curvilinear triangular diagrams. The same method applies to a variety of amphipods belonging to different families, for example the genera *Harpinia*, *Stegocephalus* and *Hyperia* (Thompson 1992: 292, 293, 294, 295, 296). The mathematical basis of organic transformations does not only pertain to larger invertebrates. Thus one encounters the hydroid zoophytes, which represent a polymorphic group with apparently infinite variations in form, size, and the arrangement of the little cups at their top called calycles. Remarkably, even these minute variations are a case of relative magnitudes which can be represented by means of Cartesian co-ordinates (Thompson 1992: 296-297).

Among fishes (of which the largest group is the class Actinopterygii, or spiny-rayed fishes, with over 13 000 species found in all aquatic habitats world-wide; Cooke *et al* 2008: 498) a great variety of deformations is evident, but these can likewise be represented by means of Cartesian co-ordinates. The following cases are depicted by Thompson: (a) The rectangular co-ordinates of the hatchet-fish (*Argyropelecus olfersi*) are transferred to oblique co-ordinates with angles of 70%, thus becoming the allied diaphanous hatchet-fish (*Sternoptyx diaphana*).

This is said to be analogous to the deformation of fossils due to the shearing-stresses in solid rock; (b) The rectangular co-ordinates of the parrotfish of the genus *Scarus* are deformed into a system of co-axial circles, thus becoming the allied angelfish (genus *Pomacanthus*), with even the coloured bands on its body corresponding to lines of curved ordinates; (c) The rectangular co-ordinates of the wreckfish of the genus *Polyprion* becomes a triangular or radial system for the short bigeye (*Pseudopriacanthus altus*) and the scorpionfish of the genus *Scorpaena*; (d) The rectangular co-ordinates of the porcupine-fish, also known as the balloonfish (genus *Diodon*), are deformed into a combination of concentric circles and hyperbolic curves which accurately represent the closely allied sunfish (*Mola mola*), although very different looking. In the latter case the Cartesian method accounts by one integral transformation for all of the external differences between the two fishes. Thus it leaves the parts near the origin of the system, e.g. the head and pectoral fin, practically unchanged, and shows an increasing modification of size and form when moving from the origin towards the periphery of the system (Thompson 1992: 298-301).

Regarding the class Reptilia, it was claimed by Thomas Huxley that the order of crocodiles provides us with an almost unbroken series of transitional forms in continuous succession across geological formations. As the top aquatic predator in their habitats, the body form of crocodiles has remained basically the same since their first appearance 220 million years ago, although they have undergone much evolution in the meantime (Cooke *et al* 2008: 367). It is therefore not surprising that Huxley's claim was transposed by Thompson as follows: 'the Crocodilea constitute a case in which, with unusually little complication from the presence of independent variants, the trend of one particular mode of transformation is visibly manifested' (1992: 301-302). Thus a variety of crocodile skulls can be represented by means of a system of Cartesian co-ordinates and its deformations, for example the saltwater crocodile (*Crocodylus porosus*), the American crocodile (*Crocodylus americanus*, alternatively *acutus*) and the small Cretaceous form *Notosuchus terrestris* (Thompson 1992: 302-303). The same method applies to a variety of Dinosaurian reptiles. For instance, the medium-sized pterosaur *Dimorphodon* can be represented by rectilinear Cartesian co-ordinates, and the very large *Pteranodon* with its elongated jaws and backwardly directed crest by a system of oblique co-ordinates in which the parallel lines become diverging rays (Thompson 1992: 305-306).

The realm of mammalian skulls represents a fertile field for the application of Thompson's theory. To begin with, the same method of Cartesian co-ordinates and its transformations is applied to extinct rhinoceros types, for example *Hyrachyus agrarius* and *Aceratehrium tridactylum*, and even for greater gaps such as that between rhinoceros, tapir, and horse (Thompson 1992: 310-312). These three related families comprise the order Perissodactyla, or odd-toed ungulates. Sadly, due to human depredations most of its 18 species are at risk of extinction in the wild (Cooke *et al* 2008: 168-173). Almost incredibly, Thompson's system of transformation applies even from rhinoceros to rabbit skulls. Thus Cartesian co-ordinates are used for the *Hyrachyus* skull and with a uniform flexure in a downward direction for the rabbit skull. Moreover, the enlargement of the eye and a modification in the form and number of teeth from *Hyrachyus* to rabbit constitute independent variations outside of general transformations, but not contradictory to it (Thompson 1992: 313-314).

The same method can be applied to the horse and its postulated ancestors. According to modern evolutionary theory, the horse family Equidae (with its 9 species in a single genus, *Equus*) descended from a dog-sized mammal that lived in North America around 54 million years ago. During its evolution the equids migrated to Asia and Africa, where the zebra and ass (or donkey) later appeared (Cooke *et al* 2008: 168). The skull of the smallest form, *Eohippus*, can be placed in a Cartesian network which is correspondingly enlarged towards the largest form, *Equus*. We find that in the case of intermediate forms such as *Mesohippus* and *Protohippus* the fossil skulls coincide with the hypothetical forms. Nonetheless, the skull of *Parahippus* does not fit into this scheme, and therefore *Parahippus* cannot stand in the direct line of descent from *Eohippus* to *Equus* but has to represent a divergent branch of the Equidae (Thompson 1992: 314-315).

When comparing human skulls with the skulls of some of the higher apes, the main differences pertain to the enlargement of the brain and the relative diminution of the jaws, as well as the facial angle increasing from oblique to nearly a right angle in *Homo sapiens*. Thus the human skull is depicted with Cartesian co-ordinates, its transformation for the chimpanzee and a more intense deformation for the baboon. Consequently, 'it becomes at one manifest that the modifications of jaws, brain-case, and the regions between are all portions of one continuous and integral process' (Thompson 1992: 318-320). However, Thompson correctly remarks, there is no series of transitional forms between Mesopithecus, Pithecanthropus, *Homo neanderthalensis*, and the various races of *Homo sapiens*. This lack of transitional forms between modern humankind and its alleged ancestors confirms that no straight line of descent exists. Instead, among both human and anthropoid types we find divergent rather than continuous variation (Thompson 1992: 320-321). In addition, the main advantages of the human being, namely his brain and hands, would have been of little competitive advantage over his supposed ancestors with their greater strength and agility (Dewar 2005: 235-236). The Darwinian speculation concerning a 'missing link' between the higher apes and *Homo sapiens* therefore has to be rejected as an exercise in futility.

Any two mammalian skulls may be compared with this method, Thompson continues, since there is something invariant in spite of the transformations. Thus the landmarks of cranial anatomy, e.g. ear, eye and nostril, retain their relative order and position throughout a series of transformations. In addition, there exists a degree of invariance between the mammalian skull and that of the bird, amphibian or fish, in that discriminant characters persist unchanged through transformation (Thompson 1992: 321). We evidently encounter a graded continuity in form among the various orders of vertebrate animals, as would be expected if variations occur within certain constraints, which in turn confirms the reality of lawful evolution.

8.3.2 Three-dimensional co-ordinate systems

That the Cartesian system outlined above is not limited to plane geometry, is demonstrated by the fact that such a system of co-ordinates can without much difficulty be transferred from two-dimensional figures to three-dimensional bodies, especially in the case of fishes (Thompson 1992: 323). Thus, when comparing a common 'round' fish such as haddock with a common 'flat' fish such as plaice, aside from differences in the position of eyes or the number of fins, the chief factor is the broadening out of the plaice's body in a dorsal-ventral direction, as well as its thinning out in another direction. We also find that the high, expanded body of the boar-fish (genus *Antigonia*) or in the sun-fish is simultaneously compressed vertically; conversely, the skate is expanded from side to side compared to the related shark or dogfish, but simultaneously depressed in its vertical section. This indicates that among fishes the dimensions of depth and breadth tend to vary inversely. Thompson also notes a relation of magnitude between the twin factors of expansion and compression: in the general process of deformation, the volume and area of a cross-section are less affected than its two linear dimensions. Thus with different-looking fishes such as haddock and plaice, they have approximately the same volume when they are equal in length. That is to say, the extent to which the plaice has broadened is compensated for by the extent to which it also became flattened – representing an extreme case of the compensation of parts (Thompson 1992: 324).

It should also be kept in mind that fishes, like birds, are subject to strict limitations of form. In a late nineteenth century study of a number of fishes and also of whales, it was found that if the areas of their cross-section are plotted against their distances from the front end of the body, the results are similar. The same study also found that the position of greatest cross-section is fixed for all the species observed, namely at a distance of 36% of total body length behind the snout. These rules naturally do not apply to extreme cases such as the eel or the balloon-fish (genus *Diodon*), which have materially modified ways of propulsion and locomotion. This evidence implies, Thompson concludes, that hydrodynamical conditions limit form and structure among aquatic vertebrates (1992: 324-325). Once more we encounter physical limitations imposed on organic forms – that is to say, variations are constrained.

8.3.3 Relevance

D'Arcy Thompson has become widely recognised as the first bio-mathematician, due to his comprehensive integration of the organic and mathematical realms. As aptly remarked by Lloyd Gerson, 'Thompson's entire project... is viewed by him as thoroughly Aristotelian. A Neoplatonist might venture the suggestion that it is thoroughly Aristotelian because it is thoroughly Platonic' (2005: 241). The relevance of mathematics in an investigation of the organic realm, and by extension the grounding of the latter in natural law, has been stated with characteristic elegance by the Scottish polymath: 'Every natural phenomenon, however simple, is really composite, and every visible action and effect is a summation of countless subordinate actions. Here mathematics shows her peculiar power, to combine and to generalise. The concept of an average, the equation to a curve, the description of a froth or cellular tissue, all come within the scope of mathematics for no other reason than that they are summations of more elementary principles or phenomena. Growth and Form are throughout of this composite nature; therefore the laws of mathematics are bound to underlie them, and her methods to be peculiarly fitted to interpret them' (1992: 270).

Accordingly, in the study of material things number, order, and position are the threefold clue to exact knowledge. In the words of Thompson (1992: 326), 'For the harmony of the world is made manifest in Form and Number, and the heart and soul and all the poetry of Natural Philosophy are embodied in the concept of mathematical beauty.' Therefore not only the movements of the heavenly bodies must be studied by means of mathematics, but whatever can be expressed by number and defined by natural law: 'So the living and the dead, things animate and inaminate, we dwellers in the world and this world in which we dwell are bound alike by physical and mathematical law' (Thompson 1992: 327). Undoubtedly, the great Hellenic protagonists of a lawful natural order would have agreed with this assessment by a remarkable twentieth century *physiologos*.

8.4 The limits of transformation

In the *Origin of Species* Darwin ascribed such abundant power to natural selection acting upon random variations, that he saw no reason why over millions of years terrestrial bears could not be transformed into aquatic whales, or flightless penguins into flying ducks (Thompson 1984: 38). In his own words, 'I can see no limit to this power, in slowly and beautifully adapting each form to the most complex relations of life' (Chapter 14; 1998: 353). However, if living species were continuously and gradually being transformed into new species, then nature should have abounded with transitional forms, as Darwin admitted (*Origin*, Chapter 6; 1998: 132). Instead, there is a glaring absence of intermediate forms both among living organisms and in the fossil record, but Darwin found a scapegoat to blame. As we are told in the *Origin*, 'Geology assuredly does not reveal any such finely graduated organic chain; and this, perhaps, is the most obvious and gravest objection which can be urged against my theory. The explanation lies, as I believe, in the extreme imperfection of the geological record' (Chapter 9; 1998: 213).

It was pointed out by Douglas Dewar that Darwin's insistence on the imperfection of the fossil record is at variance with the facts (2005: 13). Already at the time of Dewar's writing (i.e. mid-twentieth century), the percentages of discovered fossils representing the mammalian genera now living were as follows: land mammals, 61.1% of 408 genera; marine mammals, 75.61% of 41 genera; flying mammals (i.e. bats), 25.56% of 215 genera; thus giving a total 50.14% fossils of 664 living genera. The relatively low percentage for bat fossils is attributed to two factors: flying animals are less likely than others to die from accidents resulting in fossilisation of their bodies; and the scarcity of geological exploration in the Tropics, where the large majority of bat genera dwell (Dewar 2005: 14). If one considers the Earth's continents in this regard, the percentages vary from 100% fossils of living genera found for Europe to 56% for Australia, reflecting the extent of geological exploration. Dewar concludes, 'The above figures indicate that in the course of their existence every genus of land mammal having hard parts is likely to leave its fossil record in the rocks' (2005: 15). The Swedish botanist Nils Heribert-Nilsson confirmed that by the middle of the twentieth century the fossil record was already so complete that the lack of transitional series could not be explained by the scarcity of material (Thompson 1984: 50).

By the early twenty-first century, i.e. 150 years after the publication of Darwin's theory, vast quantities of fossils had been unearthed, also in the previously less explored continents of Asia, Africa and Australia. However, the 'missing links' Darwin had hoped for are still missing, since predominantly more members of the same species, more species of the same genera, and more classes from the same phyla have been discovered. An exception to this rule is the new phyla and species found at the Burgess Shale site in Canada, but it still yielded no intermediates between the previously known phyla. As remarked by David Swift, 'So we have many millions of fossils, classified into hundreds of thousands of species, but the radical divisions between groups of organisms persist: the longed-for links remain as elusive as ever' (2002: 259). Lev Berg had earlier pointed out that the lack of transitional forms in the fossil record applies to the transitions between phyla and classes, for example from fishes to tetrapods; from cartilaginous to higher fishes; and even from reptiles to birds, in spite of their apparent affinities (1969: 347).

According to the modern evolutionary theory, vertebrates evolved from invertebrate chordates, of which lancelets (or amphioxus) and sea squirts (or tunicates) are living representatives (Cooke *et al* 2008: 518). However, the postulation of amphioxus as a vertebrate ancestor has been challenged by David Swift, since these cephalocordates have no equivalent to the vertebrate brain, or the neural crest cells and hard tissues of vertebrates. And since there are no known intermediates between cephalocordates and vertebrates, it is nothing more than conjecture that the latter evolved from the former (Swift 2002: 264).

Eventually terrestrial animal life is said to have arisen with amphibians evolving out of fishes towards the end of the Devonian period (around 380 millions of years ago, hereafter MYA), reptiles out of amphibians during the Carboniferous (around 350 MYA), mammals out of reptiles during the Triassic (around 220 MYA), and birds out of dinosaurs during the Jurassic, around 140 MYA (Cooke *et al* 2008: 28-29). Regarding the earliest vertebrates, it is claimed that jawed fishes evolved from jawless fishes, for instance through the transformation of the gill arch into jaws. However, no intermediates between jawless and jawed fishes are known. Furthermore, there are several distinct groups among the early jawed fishes, such as the spiny sharks of which there is no trace of any ancestors or any forms linking them with modern cartilaginous fish. The morphological diversity among the early jawed fishes (the placoderms) is in fact attributed by most palaeontologists to polyphyletic (i.e. multiple) origins. Regarding bony fishes, which first appeared in the Devonian, we find two main groups defined by the structure and control of their fins, namely ray-finned and lobe-finned fish. Both groups appear fully differentiated and at approximately the same time in the fossil record, without any known common ancestor (Swift 2002: 264-265).

Since it is physiologically and mechanically impossible for a ray-finned fish to be gradually transformed into an amphibian, as pointed out by Douglas Dewar (2005: 39), the proponents of gradual transformism aver that tetrapods evolved from lobe-finned fishes, such as the lungfishes now living in Africa and South America. These differ from ray-finned fishes by possessing muscular fins enabling them to transverse dry land, as well as lungs to survive in waters with low oxygen levels (Cooke *et al* 2008: 468). An evolutionary series from lobe-finned fishes to tetrapods has been postulated by Denis Alexander, beginning with the fossil *Pandericthys* found in Latvia and dating from the mid-Devonian period. It had a pectoral fin and shoulder girdle intermediate between those of a lobe-finned fish and a tetrapod. In this scheme the early tetrapods are represented by the fossils of *Ichthyostega* and *Acanthostega*, found in Greenland and dating from the late Devonian period. They possessed the flat-topped skulls of later tetrapods, as well as front and hind limbs with digits. In 2006 fossils of a previously unknown species, *Tiktaalik*, were discovered in northern Canada, also dating from the late Devonian. These crocodile-sized animals had limb-like fins and an elbow joint, which could have enabled *Tiktaalik* to inhabit the shallow waters and adjacent land of what had been a semi-tropical wetland before continental drift set in. This species has (predictably) been posited as a transitional form between fishes and tetrapods (Alexander 2008: 128-129).

However, there are a number of structural differences between lobe-finned fish and the early amphibians which weigh heavily against the possibility of a gradual transformation. First, the bones of the posterior fins of the lobe-finned fish are not attached to the backbone, whereas in tetrapods the hind limbs are thus connected by way of a pelvis. Second, there is no equivalent in the last known fish predecessor to the polydactyl limb of the first amphibians. A third divergence pertains to the overall orientation of the limbs, which are swept backward in fish and directed forwards in amphibians (for movement in water and on land, respectively). Fourth, the ribs of amphibians (dorsal only) are not homologous to those of the lobe-finned fishes (both dorsal and ventral). Moreover, despite certain structural features shared by all three groups of modern amphibians (anurans, urodeles and caecilians) there is no known common ancestor, since all of these appear fully differentiated in the Jurassic rocks. This phenomenon suggests a polyphyletic origin for amphibians, as is the case with the jawed fish (Swift 2002: 266, 268, 322).

Regarding the transformation from amphibians into reptiles, we are again confronted with fundamental morphological differences, pertaining especially to their eggs, reproductive organs, and breathing apparatuses. Another non-homology is found in their scales, which in the case of fish and early amphibians are bony and arise from the dermis, whereas in reptiles the scales are non-bony and arise from the epidermis. Moreover, as in the case of the amphibians, various new reptile groups appear in the fossil record fully differentiated for terrestrial, aquatic or aerial life. Well-known examples of these groups are the dinosaurs, ichthyosaurs and pterosaurs, respectively – again with no known intermediaries linking them (Swift 2002: 268-270, 322-323). Regarding the egg and the embryo alone a whole range of transformations between amphibian and reptile would be required, for example abandoning metamorphosis and arranging a water supply for the embryo, the formation of new organs such as the amnion and the allantois, and the development of a tooth for breaking the hard egg shell. Moreover, most of these changes would have been useless or even harmful to the embryo until they were more or less complete (Dewar 2005: 219-220). It is now known that the development of an amniotic egg occurred first among reptiles, which facilitated the widespread colonisation of land by vertebrates. These eggs protect the developing embryo within a shell that is permeable to gases such as oxygen and carbon dioxide, while restricting water loss (Cooke *et al* 2008: 26).

The existence in the Carboniferous period of fully aquatic reptiles such as the genus *Mesosaurus*, of which fossils have been found in Southern Africa and South America, has led Douglas Dewar to satirise the transformist position as follows: ‘If the doctrine of transformism be true the ways of animals in the past were indeed strange. Fishes which had laboriously turned their fins into legs and become amphibians lost no time in ridding themselves not only of their newly-acquired legs, but of their limb girdles, lock stock and barrel. Again, no sooner had certain amphibians acquired the power of producing eggs that could be incubated out of water than some of them took to living in water’ (2005: 44).

Regarding the transformation of reptiles into birds, we encounter fundamental obstacles in the transition from cold-blooded to warm-blooded organisms, from scales into intricate feathers,[31] and from leaping between trees to the mechanism of winged flight, with the concomitant transformation of fore-limbs into wings – all of these supposedly taking place gradually over numerous generations (Dewar 2005: 220-223). The Jurassic fossil of *Archaeopteryx*, with its fully developed feathers, is one of the earliest known birds. Due to its possession of a long bony tail, claws on its digits, and teeth, this bird has been proclaimed as a transitional form linking birds with reptiles, supposedly deriving from the dinosaurs known as theropods (Swift 2002: 271, 309). However, it has been shown by Dewar that none of the alleged reptilian features of *Archaeopteryx*, such as the skull, non-pneumatic bones, vertebrae, and pectoral and pelvic girdles, are limited to the order of Reptilia. Even the teeth of *Archaeopteryx* is no evidence of a reptilian link, since all the known birds of the Cretaceous and Jurassic periods had teeth, while modern turtles and tortoises lack teeth (Dewar 2005: 51-52). In addition, the various skeletal differences (pelvis, digits, and fore-limbs) between theropods and birds count strongly against an ancestral relationship. A further difference is that modern birds possess a single thoracic cavity for the distribution of air around their bodies, thereby facilitating the high metabolism related to flying, whereas theropods (and modern reptiles such as crocodiles) require a thorax divided into two separate chambers. Moreover, the most bird-like theropods only appeared in the late Cretaceous, i.e. around 70 million years after *Archaeopteryx*. It therefore has to be concluded that *Archaeopteryx* was intermediate between reptiles and birds in terms of morphology, but not in phylogeny (Swift 2002: 271-272).

Regarding the supposed transformation of reptiles into mammals, we are again confronted with physiological obstacles. For instance, the imagined conversion of reptilian jaws and ear bones into those of a mammal disregards the fundamental structural differences between their skeletons. The hypothesis of gradual transformation also fails to explain how or why the Organ of Corti developed in the mammalian middle ear while the jaws and ear bones were being drastically modified. This auditory apparatus, although comprising around 3 000 arches forming a tunnel and supplied by hundreds of nerves, would have been useless in the struggle for survival until it was complete or nearly so. Moreover, similar or even greater changes would have to occur in the remainder of the skeletal structure, not to mention the circulatory, respiratory and digestive systems, the body covering, the transition from cold-blooded to warm-blooded organisms, and the formation of mammary glands in order to transform a

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[31] It was suggested by Alfred Wallace that a bird’s feather and wings demonstrate a preconceived design, both in its microscopic intricacies and its macroscopic beauty (Flannery 2011: 24-25).

reptile into a mammal (Dewar 2005: 54-55, 223-225). More recently, palaeontologists such as Erik Jarvik and Hans Bjerring have contested the presumed transformation of reptilian jaw bones into mammalian ear bones. It was also admitted by Niles Eldredge (of punctuated equilibrium fame) that the fossil record does not support the transformation of jaw bones into middle ear bones (Swift 2002: 274). Interestingly, according to the geneticist Otto Schindewolf it is feasible that in the reptilian lineages that led to mammals a gradual reduction of the bones of the lower jaw could have taken place. 'However', he adds, 'the fundamentally decisive, final step – the complete disappearance of these bones or their transformation into elements of the auditory area – must have taken place *discontinuously, suddenly, between one individual and the next, during an embryonic developmental stage*' (quoted in Davison 2000: 33). The evidence thus indicates that any evolution of reptiles into mammals is physically impossible through gradual transformation, instead requiring a macro-evolutionary mutational jump.

As is the case with other vertebrate classes, the three divisions of modern mammals (monotremes, marsupials and placentals) appear in the fossil record fully differentiated, with no trace of intermediates. In the case of placental mammals this *ab initio* differentiation pertains to most of its 30 orders. Moreover, those mammals specialised for aerial and aquatic life, namely bats and cetaceans, appear in the fossil record fully adapted. Bats first appear in the Eocene epoch around 50 million years ago, fully specialised for flying and apparently also using echolocation. There is no palaeontological or morphological evidence to indicate that bats evolved out of suggested intermediates such as flying lemurs or squirrels (which are actually gliders unable to fly). Whales appear suddenly in the early Tertiary period, fully adapted for swimming with fore-limbs modified as flippers, and with fundamental changes to the ear to enable echolocation (Swift 2002: 274-275; Dewar 2005: 235).

Since the 1860s the evolution of the horse from small Eocene forms to the modern genus *Equus* has been one of the mainstays of evolutionary theory. Its series is postulated to have commenced with *Hyracotherium* (formerly known as *Eohippus*), around 55 million years ago. During the remainder of the Eocene and then the Oligocene, the Miocene, the Pliocene and the Pleistocene epochs this fox-sized mammal supposedly developed through a range of intermediate types to the modern horse *Equus*. This series of morphological changes entailed three main components: an overall increase in size; the reduction of the toes into a single large toe; and the enlargement of the teeth into molars to accommodate the change of feeding habits from browsing to grazing (Swift 2002: 282-284). The fossil record indicates that *Hyracotherium* spread to Eurasia during the Eocene, but became separated from its North American population when the continents split. The Eurasian population became extinct in the Oligocene, but not before it had diversified and also developed characteristics such as increased body size and advanced teeth. This implies that either the same mutations arose in these different populations of *Hyracotherium*, or (more likely) that the diversification arose from segregation of the genes already present in the original population. The ancestry of the modern horse could thus be viewed as a case of limited evolution due to gene segregation and natural selection (Swift 2002: 292, 377). In other words, it is conceivable that the modern species of the genus *Equus* (e.g. horse, donkey, and zebra) developed from earlier forms by means of micro-evolution, i.e. genetic reshuffling and natural selection.

According to the modern evolutionary theory, the mammals of the order Cetacea (i.e. whales and dolphins) are descended from terrestrial ancestors that returned to the water around 50 million years ago (Cooke *et al* 2008: 204). In an essay titled *Hooking Leviathan by its past*, Stephen Gould sketched the postulated descent of the cetaceans. The fossil record suggests that around 52 million years ago certain species that were fully terrestrial yet at home in the water, like modern otters, began to return to the marine habitat of their distant ancestors. Over the next 5 to 10 million years they lost their hind legs, to be replaced by a powerful tail propelling them through water with an undulating dorsal-ventral movement. Their front legs became streamlined flippers for steering in the water, and their ear bones became fused into a stronger jawbone since the mechanism for hearing in water differs from that on land. The fossils of these ‘transitional’ species (*Pakicetus*, *Ambulocetus*, *Indocetus* and *Rhodocetus*) were discovered in India and Pakistan, with fossils of the early whale *Basilosaurus* (around 45 million years ago) hailing from Egypt (Gould 2007: 615-629).

However, the existence of mammals such as polar bears and sea-otters is problematic for the afore-mentioned hypothesis, since they are fully at home in water and yet are morphologically similar to their land-dwelling relatives (except for the webbed toes of the sea-otter). Since these predators are able to hunt successfully both on land and in the sea, there appears to be no necessity for a complete transformation from a terrestrial to an aquatic mode of life in order to survive in both habitats (Dewar 2005: 234). It is noteworthy in this regard that recent genetic studies have determined whales and dolphins to be ungulates, closely related to the hippopotamus (Cooke *et al* 2008: 162), another land-dwelling form that is yet fully at home in water. As quipped by Douglas Dewar, the return of terrestrial mammals to a fully aquatic mode of life requires belief in two major miracles, namely the gradual transformation of morphological structures over million of years, and the preservation during this period of countless generations of animals unable to either walk or swim properly. This is in contrast to the theological doctrine of special creation, which requires only one miracle, namely the creation of the first whale. Ironically, the belief in the unlimited power of gradual transformation thus requires more belief in the miraculous than is required by belief in special creation (Dewar 2005: 219).

An interesting anomaly has been noted by Dewar, namely the ratio between types and species in various large groups of animals and plants. The British-Indian ornithologist reasons that if types and species are formed through the accumulation of variations or mutations (as is asserted in Darwinism), then a group rich in types (i.e. morphological variety) should invariably contain more species than a group poor in types. However, the opposite is often the case, so that the number of species in the group is in inverse proportion to the number of types it contains. For instance, crustaceans and mammals are rich in types and poor in species, whereas insects and birds are poor in types and rich in species. The same rule is found in the plant kingdom: whereas the greenbrier (Smilaceae), rose (Rosaceae) and lily (Liliaceae) families are rich in types and poor in species, the aster (Compositae), true grass (Gramineae) and legume (Leguminosae) families are rich in species and poor in types (Dewar 2005: 243).

As a final remark in this context, we encounter not only an absence of transitional forms between the larger taxonomic units, but also a lack of experimental production of new characters. Instead, mostly regressive mutations occur with a loss of genetic factors, and no production of new ones (Berg 1969: 358-359). Ultimately there is a genetic reason for the absence of transitional forms in both the fossil record and among living forms, John Davison suggests: ‘if specific information was preformed in the evolving genome there would be no need for gradual transformations from one form to another’ (2006: 3). Moreover, the absence of intermediate forms implies that a primary role for natural selection is to prevent variation and accordingly to maintain the *status quo* (Davison 2000: 29). In a later chapter we will present evidence of the mostly conservative role played by natural selection, instead of being a progressive agency as is emphasised in the Darwinian tradition.

9: Modern evolutionary theory

9.1 Introduction

The traditional understanding of evolution as the unfolding of that which has been in-folded has been touched upon in the Introduction. In contrast to this metaphysical conception, the modern evolutionary theory (i.e. Darwinism in all of its permutations) proclaims the transmutation of species through contingent events. As defined in the *Oxford Dictionary of Philosophy*, evolution is 'the genetic transformations of populations through time, resulting from genetic variation and the subsequent impact of the environment on rates of reproductive success' (Blackburn 2008: 123). That is to say, new species arise through the dual mechanism of (random) variation and natural selection, the latter preserving those variations conducive to survival and reproduction of the organism. In addition to these mechanisms of transformation, the modern theory of evolution asserts the gradualism of evolutionary change from simple to more complex forms over immense periods of time. Thus 'evolution' is defined in the *Oxford Dictionary of Biology*: 'The gradual process by which the present diversity of plant and animal life arose from the earliest and most primitive organisms, which is believed to have been continuing for at least the past 3 000 million years' (quoted in Van Vrekhem 2012: 11).

Rather ironically in view of further developments, the term 'evolution' was first applied to Darwin's theory by the sociologist Herbert Spencer and not by Darwin himself. Spencer juxtaposed the development of an individual organism from an egg to an adult with the transformation of species from a protozoon to a mammal, describing both as indisputable processes of evolution (Bakar 2003: 159). This terminological confusion entails an inevitable metaphysical distortion, as explained by Etienne Gilson: 'The root of the difficulties is the fundamental indetermination of the notion of evolution. The notion signified something as long as it concerned the development of that which was supposedly enveloped, but Spencer popularized the word in another sense which no one could easily define. Far from being the development of that enveloped, Spencer's system of evolution is a prodigious system of epigenesis where each moment adds something new to the one preceding it… But whereas one understood an evolution in which the less issued from the greater in which it was contained, that form of evolution in which the greater continually springs from the less is incomprehensible' (1984: 103). This reasoning reflects the metaphysical notion that the lesser can only proceed from the greater, and not the other way round.

As biological component of the modern scientific paradigm, Darwinism rejects any notion of formal and final causality, insisting that matter and mechanism (i.e. material and efficient causes) are the only factors involved in the establishment of biodiversity on Earth. Regarding final causality, Darwin's theory of natural selection has been depicted by D'Arcy Thompson as entailing teleology without a *telos*, with the 'final cause' being little more than the result of sifting the better from the worse – in other words, it is a process of mechanism (Thompson 1992: 4). According to Lev Berg a strictly mechanistic conception of life is only feasible on the assumption that 'living machines' can be constructed by inorganic natural forces alone. However, such a notion is as unjustifiable as claiming that a watch or a steam engine or Tolstoy's *War and Peace* could be produced by the blind agency of atoms, without any intervention on the part of the human mind (Berg 1969: 2).

There is furthermore an ideological underpinning to the modern theory of evolution, one which is mostly ignored in both academic and popular literature on the subject. In his work *At the Edge of History*, the philosopher of science William Thompson suggests that Darwin was prompted to reason the way he did on account of living in an empire that placed the white race at the end of a long line of progress culminating in an Englishman, and an economic system in which the market is red in tooth and claw (Flannery 2011: 215). In his turn the geneticist Richard Lewontin argued that Darwin took the early nineteenth-century *political* economy of Adam Smith and his followers, and expanded it to include all of the *natural* economy (Van Vrekhem 2012: 106). And the historian Edward Larson attributed Darwin's world-view to the utilitarianism and *laissez-faire* capitalism of his day, having come from a family of successful capitalists himself. In the words of Larson, 'Natural selection intuitively seemed the right answer to a man immersed in the productive, competitive world of early Victorian England' (quoted in Van Vrekhem 2012: 106). This implies further that Darwinism has been serving as a useful ancillary to capitalism, one of the primary ideological components of the ongoing project to establish a totalitarian globalist hyper-state.

9.2 Darwin and natural selection

There exists a popular perception that Darwin arrived at his theory of natural selection purely due to the weight of empirical evidence. However, when one considers his inner motivation a rather different picture emerges. For instance, already during his celebrated voyage on the naval survey vessel *Beagle* (1831-1836), Darwin lost all faith in the Biblical teaching on

God’s creation of the world, including the organic realm. The immense biodiversity, including minute adaptations to local conditions, which the English naturalist observed during his circumnavigation of the world, weighed for him against the notion of a divine Creator (Swift 2002: 78). Darwin consequently became an agnostic and remained such by his own confession until the end of his life (Gilson 2009: 65; Van Vrekhem 2012: 21).

Darwin published his magnum opus *On the Origin of Species by Means of Natural Selection* in 1859. In its introduction the theory is encapsulated as follows: ‘As many more individuals of each species are born than can possibly survive; and as, consequently, there is a frequently recurring struggle for existence, it follows that any being, if it vary however slightly in any manner profitable to itself, under the complex and sometimes varying conditions of life, will have a better chance of surviving, and thus be *naturally selected*. From the strong principle of inheritance, any selected variety will tend to propagate its new and modified form’ (1998: 6). Darwin added that natural selection constantly scrutinises every variation, however slight, rejecting the bad ones and preserving the good ones, silently and slowly improving each organic being in relation to its conditions of life (1998: 66). The Darwinian thesis thus depends on three premises: the occurrence of variations; the inheritance of variations; and the preservation of beneficial variations by means of natural selection. Each of these premises, Michael Denton remarks, are practically self-evident (quoted in Van Vrekhem 2012: 36).

Although Darwin emphasised the role of natural selection in the evolutionary process, he did not assert selection to have been the sole cause thereof. Thus in the introduction to *The Origin of Species* he wrote that natural selection has been the main, but not exclusive, means of modification (1998: 7). This approach became expanded in the sixth edition of the *Origin* (1872) as follows: ‘Species have been modified... chiefly through the natural selection of numerous, successive, slight, favourable variations, aided in an important manner by the inherited effects of the use and disuse of parts; and in an unimportant manner, that is in relation to adaptive structures, by the direct action of external conditions, and by variations which seem to us in our ignorance to arise spontaneously. It appears that I formerly underrated the frequency and value of these latter forms of variation, as leading to permanent modifications of structure independently of natural selection’ (quoted in Berg 1969: 16-17). In this way Darwin both recognised the role of external factors in producing variations and incorporated Lamarckian elements by referring to the inheritance of acquired characteristics.

Like Jean-Baptiste Lamarck (the eminent French naturalist who published his theory of evolution in his work *Philosophie zoologique* in 1809), Darwin believed that variations arise due to the action of the environment and the use or disuse of organs (Popov 2009: 202). Moreover, Darwin viewed variation as practically unlimited, thereby always providing natural selection with resources. Accordingly, ‘He believed that selection could do everything by small steps over a long period, comparing natural selection with an architect who is forced to build a majestic building with crude stones and yet fulfils the task successfully’ (Popov 2009: 202-203). In other words, if given sufficient time the interaction between variation and selection will always produce new species of animals and plants.

According to Darwin’s theory, all species of living beings on Earth have evolved from one or a few common ancestors over immense periods of time. Instead of the prevailing belief that all species of plants and animals had been created separately by Divine edict, nature was now viewed as an organic continuum, in which all animals and plants are descended from very few progenitors. As stated by Darwin, ‘Therefore I should infer from analogy that probably all the organic beings which have ever lived on this earth have descended from some one primordial form, into which life was first breathed’ (1998: 364). This view became known as the theory of monophyletic origins, as opposed to that of polyphyletic origins. In addition, Darwin did acknowledge difficulties regarding his theory, which are discussed in Chapters 6 to 8 of the *Origin of Species*. These are (i) the absence of transitional forms in nature, where species instead appear as well defined; (ii) the production of complex organs such as the eye by natural selection; (iii) the acquisition and modification of instincts, for example the precise construction of bee cells, through natural selection; and (iv) the sterility of the offspring when species are crossed, compared to their fertility when varieties are crossed (1998: 132-133). However, this frank admission of problematic aspects did not prevent the *Origin* from becoming firmly established as the sacred writ, as it were, of the modern evolutionary theory.

Towards the end of the *Origin of Species*, Darwin argued that ‘species are produced and exterminated by slowly acting and still existing causes, and not by miraculous acts of creation and by catastrophes’ (1998: 367). With this assertion Darwin simultaneously confronted Moses (to whom the Genesis creation account was historically attributed) and Georges Cuvier (the famous exponent of catastrophism rather than uniformitarianism in geology), as remarked by Etienne Gilson (2009: 176). Darwin himself admitted to having two distinct objects in view: ‘firstly to show that species had not been separately created, and second, that natural selection had been the chief agent of change' (quoted in Van Vrekhem 2012: 35). Accordingly, in the *Origin* the English naturalist replaced one theology (the Divine creation of species, which he detested) by another, which could explain the popular cult of natural selection under the name of evolutionism (Gilson 2009: 177). In the words of the philosopher of science Michael Ruse: 'Darwin may not have convinced people of natural selection. He did, however, convince them of the fact of evolution' (quoted in Van Vrekhem 2012: 37).

Nonetheless, it has to be admitted that the natural theologians of the Victorian era conceived the Creator in anthropomorphic instead of transcendent terms (Flannery 2011: 44). Their argument from design also provided little more than the illusion of verification and was thus unable to prove that God actually exists (Thompson 1981: 206). These arguments provided easy targets for the more perceptive figures among the materialistic and atheistic opponents of natural theology. However, Darwin's attempt to overcome the deficiencies of natural theology by an approach based entirely on physical principles was equally erroneous, as the mathematician Richard Thompson pointed out by means of a striking image: 'Speculation resting on a finite set of material observations is indeed inadequate to provide knowledge about a supreme transcendental being. But the answer to this problem is not to deny the existence of such a being and to seek explanations solely in familiar physical principles. This is the fallacy of the drunk who lost his keys near the doorsteps of his house but would search for them only under a streetlamp because the light was better there' (1981: 206-207).

Darwin concluded the *Origin* with a poetic statement: 'There is grandeur in this view of life, with its several powers, having been originally breathed into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, and are being, evolved' (1998: 369). It is pertinent to note that from the second edition of the work onwards, Darwin added the phrase 'by the Creator' after the words 'originally breathed'. This belated reference to a Creator appears to have been a tactical maneuver, since Darwin fervently believed that natural selection does not require any Divine influence to operate efficiently.

9.3 Dobzhansky and the modern evolutionary synthesis

The foundations of what eventually became known as the modern evolutionary synthesis were laid step by step during the late nineteenth and early twentieth centuries. Although Darwin had postulated natural selection as the primary mechanism of evolution, he did not present a satisfactory explanation of how new species arise. At the beginning of the nineteenth century it had been suggested by Jean-Baptiste Lamarck (who also coined the term ‘biology’) that the characteristics acquired by a particular generation are transmitted to their offspring. The French naturalist used the famous argument that if a giraffe was constantly stretching its neck to reach leaves in higher branches, a slightly longer neck would be inherited by its offspring, and in the course of successive generations with slight modifications a new species would be formed. However, Lamarck’s theory that acquired characteristics are inherited came to be rejected by the burgeoning new science of genetics.

Through his cross-breeding of tens of thousands of pea plants, the Austrian abbot Gregor Mendel discovered the basic laws of inheritance. Yet although he described the laws of heredity in statistical terms (e.g. the number of hybrid, dominant, or recessive plants among offspring), Mendel was unaware of the hereditary mechanism (Van Vrekhem 2012: 107). Nonetheless, his discovery that inheritance depended on discrete factors which remained intact during reproduction, instead of becoming blended as had previously been thought, would be of lasting significance for evolutionary theory (Swift 2002: 95). Mendel also made a distinction that was to become axiomatic in genetics, namely the physical traits possessed by a given generation and those it transmits to subsequent generations; in other words, the distinction between phenotype and genotype (Fuller 2008: 85).

In his turn the German biologist August Weismann used insights from the new science of cytology (i.e. the study of the cell) to formulate his own ‘germ plasm’ theory. In terms thereof, all multicellular organisms have two kinds of cells: a small number of reproductive cells that convey information from parents to offspring, and a large number of somatic cells that undertake the ordinary bodily functions. Moreover, the reproductive cells (i.e. the ‘germ plasm’) cannot be influenced or changed by anything from the rest of the organism or its environment (Van Vrekhem 2012: 109). Thus, since the hereditary material controls the form of the organism’s body, but not vice versa, acquired characteristics cannot be inherited as Lamarck believed. Weismann held further that variations can only arise through mutation of the germ plasm, since mutations of the somatic tissues are not inheritable. In their turn mutations arise through miscopying of the germ plasm, and the task of natural selection is to prevent the reproduction of mutations that are detrimental to the organism (Swift 2002: 91).

By the late nineteenth century Mendel’s pioneering work on heredity was rediscovered by

Hugo de Vries and other scientists. The Dutch botanist argued that specific traits in organisms are inherited, carried along by particles he called ‘pangenes’. This term would eventually become ‘genes’, indicating specific elements in the hereditary material (Van Vrekhem 2012: 111-112). Each of these ‘pangenes’ controls specific characteristics of an organism, and their different combinations explain the varieties displayed by the same species (Swift 2002: 92). De Vries then conducted a series of experiments with plant hybrids, albeit in his case working with the evening primrose rather than peas. He concluded that new species appear suddenly, through discontinuous ‘jumps’ called mutations, and not gradually through slight, successive variations as Darwin had argued (Van Vrekhem 2012: 112). In other words, these ‘macro-mutations’ were viewed by De Vries (and his famous contemporary, the geneticist William Bateson) as far more important in the production of new species than the gradual accumulation of minor changes through natural selection (Swift 2002: 92, 95). We contend that these two mechanisms underlie macro- and micro-evolution, respectively.

Remarkably, by the beginning of the twentieth century Darwin’s theory of evolution had become all but eclipsed by alternative theories on the origins of biodiversity, for example saltationism (the mutational jumps of De Vries, Bateson and others) and orthogenesis, or directed evolution (which we will consider in a later chapter). Then mathematicians such as John Haldane, Ronald Fisher and Sewall Wright came to the rescue of the theory of natural selection by providing it with a mathematical basis, including statistical models (Van Vrekhem 2012: 113-114). Employing probability theory, Fisher likened the operation of natural selection to a casino that makes a profit for its owner by manipulating the odds for success. In his turn Wright had been inspired by Mendel’s work with plants in his own experiments with cattle-breeding, in which herds were segregated to counteract the effects of random genetic drift (Fuller 2008: 86, 127). We again notice how ‘natural selection’ is modified and even counteracted by means of artificial selection. Their work, alongside the experimental work on the fruit fly *Drosophila* conducted by Thomas Morgan and his colleagues, gave rise to population genetics. The proponents of the latter differed from Darwin in postulating evolution as taking place on the level of the species, and not of the individual as he believed (Swift 2002: 98-99). However, it has recently been argued by John Davison that since all evolutionary changes originate in individual chromosomes in individual germinal cells in individual organisms, population genetics has a questionable place in the evolutionary process (2000: 31).

Of lasting relevance for Darwinism was the publication of *Genetics and the Origin of Species* by Theodosius Dobzhansky in 1937. In this work the Russian-born geneticist (and co-worker of Thomas Morgan in his experiments) combined natural selection with genetic mutation, the latter being the cause of variation. This combination of evolutionary mechanisms would become known as the modern evolutionary synthesis (Van Vrekhem 2012: 116). In a later work, *The Biology of Ultimate Concern*, Dobzhansky depicted evolution as comprising three levels or stages: (i) the production of genetic raw materials through mutation; (ii) the formation, through natural selection and Mendelian recombination, of genetic endowments adapted to survive and reproduce; and (iii) the establishment of limits between species through reproductive isolation (Dobzhansky 1967: 121). However, mutations (i.e. changes in genes and chromosomes) are ambiguous, since they could be either useful or harmful to the organism. Dobzhansky notes that most mutations are actually harmful, since they produce defects or diseases, and some are even lethal. Yet a minority of mutations are not harmful to the organism but useful, especially when the organism's living environment is altered. Through natural selection harmful genes are then reduced in frequency, while useful genes are perpetuated. It is emphasised by Dobzhansky that natural selection works not with genes but with organisms, since it is individual organisms that either die without offspring or produces offspring (1967: 121-122).

It is interesting that the anthropological implications of Darwin's theory have not featured in the Neo-Darwinian synthesis. In this tactic the formulators of the latter followed the example of Darwin himself, who in *The Origin of Species* omitted any mention of *Homo sapiens* being the product of natural selection.[32] Although Darwin later wrote *The Descent of Man* to complete the application of his theory, his anthropological views were and still are deemed politically incorrect, as remarked by Steve Fuller (2008: 142-143).

By the beginning of the twenty-first century the Neo-Darwinian synthesis had come to embrace the following principles: (i) Genes act as units of information in DNA molecules; (ii) the traits of an organism (the phenotype) express the information in its genes (the genotype); (iii) differences in genetic information produce variation in traits; (iv) genetic changes are due to random mutations and are therefore unpredictable; (v) variations in traits in a population occur due to mutational events, a process known as genetic drift; and (vi) natural selection

[32] The third last paragraph of *The Origin of Species* ends with the cryptic statement, 'Light will be thrown on the origin of man and his history' (1998: 368).

operates on a pool of genetic variants, bringing about survival of greater reproductive fitness (Hewlett 2006: 175). However, the lack of constructive mutations presents a serious challenge to Neo-Darwinism, as David Swift remarked. In spite of extensive laboratory work to generate mutations, not a single case is known of it leading to constructive morphological change. And the reason for this absence of beneficial mutations is the improbability of biological macro-molecules arising due to chance processes. Instead, proteins and RNA were fully functional at the time of their first appearance, followed ever since by variations in their amino acid sequences which are not susceptible to selective scrutiny (Swift 2002: 374).

It is noteworthy that Dobzhansky did not fully agree with the prevailing rejection of teleology in biological circles, as is evident from the following passage he wrote: ‘Seen in retrospect, evolution as a whole doubtless had a general direction, from simple to complex, from dependence on to a relative independence of the environment, to greater and greater autonomy of individuals, greater and greater development of sense organs and nervous systems conveying and processing information about the state of the organism’s surroundings, and finally greater and greater consciousness. You can call this direction progress or by some other name’ (quoted in van Vrekhem 2012: 168-169). Evidently, in the Neo-Darwinian conception ‘the deterministic mechanisms of natural selection provide systematic guidance for the development of species’, thereby counter-balancing the random arising of variations (Thompson 1981: 132).

9.4 Gould and punctuated equilibrium

One of the major scientific thinkers of the second half of the twentieth century was the American palaeontologist Stephen Jay Gould, who together with his colleague Niles Eldredge postulated the theory of punctuated equilibrium in a 1972 paper. Through their field research they became convinced that evolution entails long periods of stasis with virtually no change in species, interrupted by short periods of explosive evolution in which new species burst into the fossil record, so to speak. The most celebrated evolutionary explosion is the sudden appearance of nearly all major types of animal life in the early Cambrian seas. Likewise most of the modern flowering plants appeared within a few million years in the middle Cretaceous period. This palaeontological evidence has been confirmed by new research on invertebrate and avian palaeontology published in 1995, which shows that at least in some lineages the evolutionary pattern was one of millions of years of stasis interrupted by periods of no more than 100 000 years of rapid change (Denton 1998: 297-298, 435).

According to Gould and Eldredge the fossil record does not agree with Darwin's thesis of gradual transformation, but rather indicates long periods of stasis (actually a Greek word meaning 'a standing') followed by the sudden appearances of new forms. The latter occurs when small segments of a population are isolated at the geographic periphery of the bulk of a species. Under environmental pressure favourable genetic variations spread quickly, until they have become established as new species (Gould 2007: 263-266). A striking example of stasis in the animal world is the coelacanth (genus *Latimeria*), whose ancestors first appear in the fossil record around 400 million years ago. This lobe-finned fish was thought to have become extinct together with the dinosaurs around 65 million years ago, until a living specimen was caught off the South African east coast in 1938. Contradicting Darwin's dictum that species are constantly changing due to the endless scrutinising of natural selection, the coelacanth has remained much the same for several hundred million of years (Van Vrekhem 2012: 164). The theory of punctuated equilibrium seemingly provides a plausible explanation for the lack of intermediates between species, while recognising the principles of population genetics as established in the early twentieth century (Swift 2002: 288).

Gould contended that the fossil record is in fact a faithful rendering of what evolutionary theory predicts in the light of punctuated equilibrium. The oldest rocks to retain fossils, being those of prokaryotic cells (such as bacteria) and stromatolites, are dated to around 3.5 billion years ago. This age implies that life remained exclusively unicellular for five sixths of its history on Earth, since multicellular organisms only began appearing around 600 million years ago. In this time the vital transition from simple prokaryotic cells to eukaryotic cells containing nuclei and mitochondria took place. Gould notes further that all the major stages in the organisation of multicellular architecture for animal life then occurred between 600 and 530 million years ago. This was followed by the remarkable Cambrian explosion starting around 530 million years ago, during which in the space of a mere five million years all but one modern phylum of animal life appeared in the fossil record. Therefore the past 500 million years of animal life amounts to little more than variations on anatomical themes established during the Cambrian explosion (Gould 2007: 215-216).

Throughout his career Gould insisted that there is no direction in evolution, employing the evidence from the Burgess Shale fossils in his book *Wonderful Life* (1989) to buttress his stance. In his view evolution should not be pictured as a branching tree with humans situated right at the top, but rather as a bush with humans being one twig among many, none being more important than any of the others. Gould pointed out the continued existence of the myriads of bacteria and several thousand of beetle species as confirmation of his argument (Ward 2008: 65-66). Interestingly, while Gould admitted that the simplest kind of cellular life arises as a predictable result of the organic chemistry and physics of self-organising systems, he denied any predictable directions for its later development (Denton 1998: 296). In addition, by rejecting the notion of direction in evolution, Gould also came to oppose the progress mythology which has always existed side by side with Darwinism. The American palaeontologist consequently viewed progress as a delusion arising from the human refusal to accept our insignificance in the face of the immensity of time (Van Vrekhem 2012: 168).

Despite his rejection of gradualism, Gould continued viewing himself as a Darwinist until the end of his life (Van Vrekhem 2012: 161). However, his English sparring partner Richard Dawkins insisted that Gould’s theory is incompatible with Darwinism. With characteristic vehemence Dawkins states the case as follows in *Unweaving the Rainbow*: ‘The extreme Gouldian view - certainly the view inspired by his rhetoric, though it is hard to tell from his own words whether he literally holds it himself - is radically different from and utterly incompatible with the standard Neo-Darwinian model. It also has implications which, once they are spelled out, anybody can see as absurd’ (quoted in Van Vrekhem 2012: 171). Ironically Dawkins, for all of his anti-teleological tirades, has not hesitated to employ design-based language in his arguments, such as ‘selfish gene’ and ‘blind watchmaker’. It appears that for Dawkins ‘adaptation’ is a secular synonym for ‘design’ and ‘natural selection’ a secular synonym for ‘God’, as wittily remarked by Steve Fuller (2008: 157).

Although rejecting gradualism, Gould fully subscribed to the contingency on which Darwinism is based. In his essay *The Evolution of Life on Earth*, Gould discussed the pervasiveness of contingency in the unfolding of life on our planet. He argues that if our particular vertebrate lineage had not been among the few survivors of the Cambrian explosion that began around 530 million years ago, then vertebrates might not have come to dominate the Earth. Further, if a small group of lobe-finned fishes had not evolved fin bones with a strong central axis capable of bearing weight on land, then vertebrates might never have become terrestrial. Then, of particular importance for mammals, if a large extraterrestrial body had not struck the Earth some 65 million years ago, then dinosaurs might still have been dominant. And finally, if a small lineage of primates had not evolved upright posture on the

African savannah between four and two million years ago, then the (postulated) human ancestry might have ended like chimpanzees or gorillas today (2007: 211). In the words of Gould, 'We are here because an odd group of fishes had a peculiar fin anatomy that could transform into legs for terrestrial creatures; because the earth never froze entirely during an ice age; because a small and tenuous species, arising in Africa a quarter of a million years ago, has managed, so far, to survive by hook and by crook. We may yearn for a "higher answer" – but none exists' (quoted in Van Vrekhem 2012: 167-168). Thus Gould's (metaphysical) assumption of contingency leads inevitably to the (existential) conclusion of meaninglessness.

A memorable yet faulty argument used by Gould is that if the tape of evolutionary history is replayed, then the outcome would be radically different. There would be nothing like human beings on Earth, and any other possible biospheres in the universe would have to be different from all the others. However, Gould's notion of radical contingency has been challenged by Simon Conway Morris, who in his work *Life's Solution* exhaustively demonstrates the ubiquity of evolutionary convergence, which confers at least a degree of predictability as to its outcome: 'Convergence simply tells us that the evolution of various biological properties is certainly highly probable, and in many cases highly predictable' (2003: 223). Referring to Gould's argument that the history of life is little more than a contingent muddle, in which the mass extinction of one group facilitates the survival of another group through sheer luck, the British palaeontologist writes: 'Yet, what we know of evolution suggests the exact reverse: convergence is ubiquitous and the constraints of life make the emergence of the various biological properties very probable, if not inevitable' (2003: 283-284). That is to say, the evolutionary process is guided by constraints and not driven by contingency, accident or luck.

Following Dobzhansky, Gould argued that natural selection occurs on the level of the organism as a whole (the phenotype), and not only on the genetic level (the genotype) as averred by Richard Dawkins. The English biologist's reduction of selection to genes struggling for reproductive success has been lambasted by the American palaeontologist as both logically flawed and a foolish caricature of Darwin's intention (Gould 1997: 3). As argued by Gould, the DNA does not determine a species; instead, it is the record of the species (Van Vrekhem 2012: 199). Gould charged Dawkins and other reductionists such as John Maynard Smith and Daniel Dennett with being 'Darwinian fundamentalists', since they failed to appreciate Darwin's insistence that natural selection is not the only mode of evolutionary change. This reductionism was already apparent in Darwin's own time, causing him to lament it in the last edition of the *Origin*, while reiterating his explicit stance in the first edition that natural selection has been the main but not the exclusive means of modification. To this Gould added the irony that modern evolutionary biology had become invigorated with non-selectionist and non-adaptationist data from the disciplines of population genetics, developmental biology, and palaeontology (Gould 1997:1-2). Regarding the scope of natural selection, Gould argued that its operation can explain certain phenomena above the level of the individual organism, such as the behaviour of an ant colony. However, it is impossible to attribute all the phenomena of organic diversity, embryological architecture, and genetic structure to natural selection alone. Also, on the genetic level, ‘natural selection does not explain why many evolutionary transitions from one nucleotide to another are neutral, and therefore nonadaptive’ (Gould 1997: 4, 7).

A biochemical objection to the theory of punctuated equilibrium has been raised by David Swift, namely that genes already have to be available in order to operate in small, isolated populations. Since new useful mutations are exceedingly rare, they have a better chance of arising in a large population. This requirement makes the arising of new genetic material in small populations practically impossible. And since small populations do not have enough genetic variability, they can only be a source of new variations, but not of speciation (Swift 2002: 289). It had similarly been argued by Darwin that although isolation plays a notable role in natural selection, a small isolated population will actually retard the production of new species, by decreasing the chance of the appearance of favourable variations (*Origin*, Chapter 4; 1998: 81). Furthermore, the notion of punctuated equilibrium suggests that the palaeontological evidence of morphological evolution results mainly from gene segregation rather than the production of new genetic material. At best, punctuated equilibrium can explain the gaps between related species, but not the transitions between higher taxa such as phyla, classes or orders, which all appear abruptly in the fossil record (2002: 289). Moreover, by asserting that new species arise in a ‘geological microsecond’ from existing species, Gould and Eldridge implied the evolutionary process to be invisible not only in practice but also in principle, ‘for a geological microsecond of 10 000 to 50 000 years is still immensely long when measured in human lifetimes’ (Thompson 1981: 186).

9.5 Criticism

It is a biographical fact that Darwin’s theory of evolution was erected upon the twin pillars provided by the geological theory of Lyell and the socio-economic theory of Malthus.

Although Darwin incorporated some aspects of biological reality into his theory, many others were left unexplained, including the mechanisms of inheritance and adaptation. In reality, apart from resting on the results of artificial breeding and the rudimentary fossil record available at the time, Darwin's theory was lacking in scientific value (Van Vrekhem 2012: 27). And as recently as 2000 the zoologist Wallace Arthur remarked that a theory of evolution that focuses so firmly on destructive rather than creative forces cannot be other than seriously incomplete (Popov 2009: 212). We will now survey some of the objections that have been raised against the Darwinian theory of evolution – scientific, philosophical, and metaphysical.

9.5.1 Variation versus speciation

Darwin's insistence that variability is practically unlimited and therefore in the long run leads to new species appearing was opposed by some of his early followers, including Huxley and Weismann. After all, as noted by Igor Popov, in spite of all the efforts by geneticists there are no blue-eyed fruit flies, no blue roses, no lupines without alkaloids, no viviparous birds or turtles, and no hexapod mammals (2009: 201, 203, 211). In his work *Darwinism. A critical research* (1885), the Russian naturalist Nikolai Danilevsky took the English biologist to task for basing his notion of infinite variability on domesticated birds. Darwin had argued that chickens are highly variable, since humans select them for many different purposes, e.g. meat, eggs, decoration, and as gamecocks. Pigeons are also highly variable, as they are selected for decorative purposes. Geese, on the other hand, are not variable because humans breed them only to serve as food (Popov 2009: 204). Danilevsky counters Darwin's argument as follows: 'Darwin confuses the cause and consequence: the goose has remained constant not because he did not fall in the list of decorative birds, which are appreciated for the beauty and strangeness of form and plumage, but on the contrary, it did not become a decorative bird like pigeons and hens, because it was and it is a non-variable species due to its nature!' (quoted in Popov 2009: 204). It was further noted by Danilevsky that in some parts of Russia, geese-fights took place just as cock-fights elsewhere. In spite of having to fight the geese never acquired spurs or any other weapon. Moreover, some other decorative birds, such as pheasants and peacocks, have remained unchanged, although they should have displayed a much greater variety if Darwin had been correct (Popov 2009: 204-205).

Astonishingly, despite the title of Darwin's epochal work he was unable to present a single example of speciation in it. The numerous cases of selection by human breeders, hailed by Darwin as proof of natural selection, produced only varieties and not a single new species

(Van Vrekhem 2012: 34). Early in the twentieth century the Russian botanist D.N. Sobolev argued that it is incorrect to view Darwinism as an evolutionary theory, since it does not explain the appearance of new forms, but only their conservation after their appearance (Popov 2009: 211-212). Even the eminent Neo-Darwinist Ernst Mayr felt compelled to admit (in *What evolution is*) that Darwin had failed to solve the problem of speciation (Van Vrekhem 2012: 34). It is undeniable that artificial selection can significantly alter the phenotype, but none of the products of selection by human breeders have exceeded the species barrier (Davison 2006: 1). The French zoologist Pierre Grassé remarked that thousands of years of cross-breeding and selection have produced innumerable variations in animals such as the dog, ox, fowl, and sheep, but none of them lost their chemical and cytological unity (Thompson 1984: 46). Moreover, the products of dog-breeding are able to interbreed not only with each other but with their wolf ancestor as well. And since the hybrid offspring of such unions are fertile, it affirms that no macro-evolution has taken place. The same applies to the goldfish bred from the Asiatic carp *Carassius auratus* (Davison 2000: 9-10).

It is noteworthy that the celebrated breeding experiments with the fruit fly *Drosophila melanogaster* over thousands of generations, involving millions of specimens, and with the mutation rate vastly increased by means of X-rays, failed to produce a single new species. In other words, the reality of micro-evolutionary variations within species cannot be doubted, but this does not support the Darwinian claim that new types of plants or animals have arisen through macro-evolutionary transformation (Smith 2008: 66-67, 80). In his work *Flaws in the Theory of Evolution* Evan Shute argued that to conclude from the observed cases of micro-evolution that ‘mega-evolution’ (e.g. birds evolving out of reptiles) occurs, is pure conjecture. Instead, micro-evolution demonstrates that there are all kinds of barriers ensuring the stability of classes and orders in the plant and animal kingdoms (Lings 1974: 113). We contend that Darwinism fails to account for speciation due to its refusal to distinguish between micro- and macro-evolution. As explained by the geneticist Richard Goldschmidt, ‘The decisive step in evolution, the first step toward macroevolution, the step from one species to another, requires another evolutionary method than that of sheer accumulation of micromutations... The fact remains that an unbiased analysis of a huge body of pertinent facts shows that macroevolution is linked to chromosomal repatterning and that the latter is a method of producing new organic reaction systems’ (quoted in Davison 2000: 13-14).

9.5.2 The origin of organic complexity

An early objection that was raised against Darwin's theory is that natural selection can provide an explanation for fine-tuning, but not the arising of complicated new structures (e.g. the eye or the wing) for which huge mutations would be required (Swift 2002: 83). Darwin acknowledged the difficulty of accounting for complex forms, such as the eye, in terms of natural selection. However, he then suggests a sequence of gradual changes from a light-sensitive spot to a mammalian eye (*Origin*, Chapter 6; 1998: 143-145). To this argument Ernst Mayr added that the evolution of the eye ultimately depends on the possession of protoplasm with photo-sensitivity, since the latter property has selective value from which all else follows by necessity. This reasoning displays a reliance on 'an abiding faith in the power of natural selection and mutation to effect transmutations in organic form', as remarked by Richard Thompson (1981: 193). The postulated evolution of the eye from light-sensitive tissues to the complex vertebrate eye is furthermore an example of the ignorance concerning the origin of new morphological structures displayed by many biologists. As explained by David Swift, 'they totally ignore the genetic or biochemical implications, and assume that variations can arise and accumulate indefinitely through the imagined plasticity of biological tissues', whereas in reality all morphological changes depend on the biochemistry of the relevant tissues. As a matter of fact, modern biochemistry undermines the Darwinian notion of evolutionary progress through small increments, since for any macro-evolutionary change new genes are required, and not merely the gene shuffling that produces variations, or micro-evolution (2002: 299-300, 315-316).

Darwin admitted that his theory would break down completely if any complex organ could be shown to have arisen without numerous, successive, slight modifications (*Origin*, Chapter 6; 1998: 146). In the light of modern biochemical knowledge it has to be stated that not only the eye but every organ fails Darwin' test, David Swift remarked, since each organ depends on complex biological structures in order to function. This also applies to the supposed transition from prokaryotic to eukaryotic cells, because it involves 'multiple inter-dependent novelties of molecular biology.' Swift concludes that 'every biological macromolecule is, in itself, of a complexity which cannot arise incrementally' (2002: 386). That is to say, a mutational 'jump' is required for the production of new genetic material. Ultimately, although the modern theory of evolution does explain facts such as the operation of natural selection at the morphological level, it fails to account for the complexity of molecular biology – at the molecular level, in the origin of life and of eukaryotic cells, and in the sudden appearance of new forms in the fossil record (Swift 2002: 386-387).

9.5.3 Sudden speciation followed by stasis

The priority of genetics over selection is evident from the observation that instead of gradual transformation, new species appear suddenly, both in the fossil record and in the experimental laboratory (Yockey 1962: 74). This phenomenon led the palaeontologist Otto Schindewolf to speak of ‘explosive evolution’, since macro-evolution takes place in an explosive manner within a short period of geological time, followed by a slow series of orthogenetic improvements (Dewar 2005: 143). In the words of Burton Guttman, ‘Each speciation event occurs quite rapidly in geological terms, so rapidly that it has sometimes been called “quantum speciation”, on analogy with the “quantum jumps” that occur in atoms and molecules’ (quoted in van Vrekhem 2012: 165). This analogy is not inappropriate, since the organic and inorganic realms are regulated by the same natural laws.

The notion of relatively sudden speciation opposes the Darwinian model of gradual transformation over immense periods of time. Even the staunch Neo-Darwinist Ernst Mayr admitted that the fossil record provides far more discontinuities than continuous series of gradually evolving species. Darwin noted that if it could be shown that numerous, related species had appeared simultaneously, his theory would be invalidated (Van Vrekhem 2012: 162). In order to counter such a rebuttal of Darwin’s theory, George Simpson postulated the existence of ‘fast-rate’ or ‘high-rate’ evolution alongside ‘normal-rate’ and ‘slow-rate’ evolution. In his *Tempo and Mode in Evolution*, the American palaeontologist suggests that most of the known low-rate organic lines must at an earlier time have been high-rate lines.[33] He employs the example of the bat’s wing, which has remained essentially unaltered since the Middle Eocene except for some diversification. Simpson concludes, ‘Extrapolation of this rate in an endeavour to estimate the time of origin from a normal mammalian manus might set that date before the origin of the earth’ (quoted in Dewar 2005: 144-145). More recently David Swift noted the discrepancy between the fossil record and the molecular clock (i.e. the rates of nucleotide substitution) as it pertains to mammals and flowering plants, being the most recently emerged groups of the animal and plant kingdoms. In both cases the molecular data suggest a much earlier origin than indicated by the fossil record. Swift concludes, ‘There are major discrepancies between the slow evolution that we can reasonably infer from morphologically related species, and the rates that are required to account for large scale

[33] It had earlier been argued by Alfred Wallace that the rate of evolution of new life-forms had been much more rapid in primitive organisms, e.g. the Foraminifera, than at present (Flannery 2011: 177).

evolution’ (2002: 285-286) – that is to say, between micro-evolution and macro-evolution.

Interestingly, it has been reasoned by the French biologist Louis Bounoure that even if finely graduated chains of fossils could be found, it would be impossible to verify any filiation between its links. ‘In other words’, Wolfgang Smith writes, ‘the transformist hypothesis is not directly verifiable in terms of palaeontological findings’ (2008: 67). Bounoure added that it would be erroneous to extrapolate from the facts established by comparative anatomy to posit an actual descent, and that in the whole of the animal kingdom there are no more than five or six series of forms that admit the possibility of organic descent. This further implies that in the celebrated ‘tree of life’ published by Ernst Haeckel in 1866, only the leaves represents taxa of real beings, whereas the large branches and trunk are entirely illusory, contrived to establish a non-existent continuity between groups. As remarked by Bounoure, they are only an hypothesis introduced to support another hypothesis (i.e. Darwin's theory), and thus have no more value than a *petitio principii*, or circular reasoning (Smith 2008: 71-72). It is therefore our contention that the confusion of morphological succession with organic descent by the proponents of transformism could be viewed as a biological version of the logical fallacy of *post hoc, ergo propter hoc* (Latin: after this, therefore because of this).

In his monumental work *The Decline of the West*, Oswald Spengler argued that Darwinism has been conclusively refuted by palaeontology, since fossils can only be samples representing different stages of evolution, and consequently there ought to be only transitional types and no defined species. Instead, we find stable forms persevering through long ages, forms that ‘appear suddenly and at once in their definitive shape’ without regard for the fitness principle postulated by Darwinism. Spengler added that these stable forms do not appear to evolve towards better adaptation, but become rarer and finally disappear, while quite different forms appear again. In view of these palaeontological facts, the German philosopher suggested a different notion of the evolutionary process: ‘What unfolds itself, in ever-increasing richness of form, is the great classes and kinds of living beings which *exist aboriginally and exist still, without transition types*, in the grouping of today’ (Spengler 1991: 231). This view accords fully with the metaphysical notion of evolution as the unfolding of inherent possibilities, instead of a transformation determined by external factors.

The American political thinker Francis Yockey, continuing the organic philosophy of history formulated by Spengler, also remarked that the fossil record shows only stable forms and no transitional types. Even in the human experience, no adaptive change has ever been observed leading to new species being formed. The simpler forms, such as bacteria, have not died out or yielded to the principles of Darwinian evolution. They have remained in the same form for millions of years, instead of evolving into something higher (Yockey 1962: 71). This phenomenon of ‘living fossils’ is quite widespread in the plant and animal kingdoms. We already mentioned the coelacanth fish, and some further well-known examples are stromatolites among bacteria; cycads, gingko trees, horse-tails and the curious *Welwitschia* of the Namib Desert among plants; the aardvark, elephant shrews, monotremes and opossums among mammals; pelicans among birds; crocodiles as well as the tuatara among reptiles; giant salamanders among amphibians; the hagfish family among jawless fishes; the mudskipper among bony fishes; many species of shark; and the mantis shrimp, horseshoe crabs and the nautilus among invertebrates (Wikipedia: Living fossils). It is interesting that many of these ‘living fossils’ produce enormous numbers of progeny, in order to ensure that some will be genetically fit. This behaviour counters the deleterious nature of most point mutations (i.e. base pair substitutions) of individual genes, which in the sexual mode tend to accumulate, leading ultimately to the extinction of the particular life-forms (Davison 2008: 28).

9.5.4 The analogy of artificial breeding

Darwin’s observation on the ability of selective breeding to produce new varieties formed the starting point of his theory, as is evident from the opening chapter of the *Origin of Species* titled ‘Variation under domestication.’ In fairness to Darwin it should be kept in mind that such vital factors in the variability of living forms as genes, Mendelian inheritance, mutations, and the endocrine system were unknown in 1859, with modern biology still in its infancy (Smith 2008: 79). It is noteworthy that Alfred Wallace rejected Darwin’s attempt to prove natural selection by means of artificial breeding as being naively anthropomorphic. Instead, Wallace remarked, such breeding demonstrates *unnatural* selection (Flannery 2011: 14). Lev Berg noted that artificial selection is based on the intelligent will of man, whereas natural selection is based on blind chance. Therefore nature cannot select those individuals which accidentally possess useful variations in order to reproduce (1969: 65). Yockey likewise criticised Darwin’s analogy between artificial breeding and natural selection, since the products of the former will inevitably be at a disadvantage against their natural varieties (1962: 72).

Various arguments against Darwin’s analogy between artificial and natural selection have been presented by Douglas Dewar in *The Transformist Illusion*, first published in 1955. First, a human breeder can effect changes in animals much faster than can occur under natural conditions, since in nature all but favourable variations are soon eliminated, whereas a human breeder can select any variation regardless of its usefulness to the animal. Second, the variations induced under artificial conditions would most probably not occur in nature; for example, the use of X-rays to accelerate the frequency of mutations. Third, in nature a new variation would most likely disappear through its possessor mating with individuals that do not display the same variation; whereas a human breeder wishing to perpetuate a variation, simply segregates the particular individual for cross-breeding with another individual possessing the same variation. Thus, the British-Indian ornithologist concludes, breeding experiments afford strong evidence against the evolutionist theory (Dewar 2005: 154-155).

Contrary to Darwin's use of the analogy of artificial selection to explain the operation of natural selection, in nature new species are formed without a stockbreeder (Gilson 2009: 179). Darwin attempted to pre-empt this objection by distinguishing between two kinds of artificial selection, namely methodical selection and unconscious selection. Methodical selection is the well-known practice of stockbreeders and horticulturalists, deliberately intended to produce new varieties of animals and plants. In contrast, 'unconscious selection' occurs when stockbreeders spontaneously and randomly choose the most interesting variations to preserve. However, Etienne Gilson pointed out, such an action remains an exercise of choice, and not an accumulation of chances through which nature is supposed to create new species. Thus Darwin's notion of 'unconscious selection' reveals itself as completely metaphorical and arbitrary. While artificial selection is not always done scientifically or methodically, it is simply false to claim that it is done unconsciously (Gilson 2009: 180-182, 184).

9.5.5 The improbability of contingency

It is one of the dogmas of Neo-Darwinian orthodoxy that the evolutionary process is driven by genetic mutations that occur randomly. However, already in 1966 Murray Eden and Marcel Schutzenberger reported the consistently negative results of random mutations in natural selection by means of probability theory (Flannery 2011: 43). Therefore, Jean Swyngedauw concluded, 'To attribute the inventions of nature to the chance action of viable mutations, which is the basic principle of all forms of Darwinism, is a gross barbarism unworthy of the biological sciences' (quoted in Van Vrekhem 2012: 118-119). The sociologist Steve Fuller remarks that if natural selection is a chance-based process, then the Darwinian theory of chance is apparently more stringent than Aristotle's view of chance as two or more independent causal processes whose outcomes coincide. However, the Neo-Darwinian grounding of natural selection in genetics implies at least a certain degree of statistical frequency (Fuller 2008: 169).

For the sake of fairness we should, however, consider the counter-argument by Theodosius Dobzhansky that the objections to Darwinian contingency are to a large degree based on a misunderstanding. Firstly, not even mutations are random changes, because the mutations in a given gene are determined by the structure of that gene (1967: 60). However, in the same work Dobzhansky writes, 'A child receives one-half of the genes of his father, and one-half of the maternal ones; which particular maternal and paternal genes are transmitted to a given child is a matter of chance. Which mutations occur, and when and where, is also a matter of chance' (1967: 126). In the Neo-Darwinian conception, mutations provide the raw materials for evolution, for which they are manipulated by natural selection. The latter, Dobzhansky adds, is only a chance process in the sense that most genotypes (i.e. offspring) have only relative advantages or disadvantages. 'Otherwise natural selection is an anti-chance agency. It makes adaptive sense out of the relative chaos of the countless combinations of mutant genes... The classical analogy between the action of natural selection and that of a sieve is... misleading. The best analogue of natural selection is a cybernetic mechanism; it transmits "information" about the state of the environment to the genotype' (1967: 60). That is to say, chance is bridled by the anti-chance agency of natural selection responding to environmental challenges (Dobzhansky 1967: 126). Nevertheless, although postulating natural selection as an anti-chance mechanism, Dobzhansky argues within a purely materialistic framework.

9.5.6 From simple to complex

The Darwinian notion that complex life-forms have evolved out of simple forms has been criticised on various grounds. For instance, the advent of the electron microscope has revealed the astonishing complexity of even unicellular organisms, so that it would be more correct to speak of organic complexity arising from relatively undifferentiated rather than simple organisms (Burckhardt 1974: 144). It is furthermore impossible for meaningful genes to arise from random variations of nucleotide sequences, David Swift points out, due to the extreme improbability of biological macromolecules arising by chance. He adds, 'There is no way in which such macromolecules can develop their activity progressively, in a trial and error manner comparable with natural selection at the morphological level, because of the minimum number of nucleotides or amino acids that need to be right for the resulting macromolecule to have any utility on which a selective process can operate. This is compounded by the fact that most macromolecules are cooperative – which means that multiple macromolecules must reach some level of utility at more or less the same time and place – which is so improbable a scenario that it must be rejected' (Swift 2002: 383).

The postulated evolution of the simple into the complex has also been opposed by means of information theory. For instance, the mathematician Richard Thompson showed that configurations of high information content, such as living organisms, cannot arise with substantial probabilities in models defined by mathematical expressions of low information content, such as the laws of nature in their modern scientific understanding (1981: 97). The implication of this limitation for evolutionary theory is considerable, as explained by Osman Bakar: 'Complex living organisms, which possess a high information content, could not arise by the action of physical-chemical laws in modern science, since these laws are represented by mathematical models of low information content' (2003: 177). Thompson adds that in a physical system governed by simple laws, any information present in the system after transformations took place had to be built into the system from the outset. Since random events are unable to give rise to definite information, Thompson concludes that the existence of a complex order here and now cannot be explained unless we postulate the prior existence of an equivalent complex order or that the information content of the system has been received from an outside source (1981: 98, 134).Therefore, either the present complexity of the organic realm has been produced by at least an equally complex order, or it has arisen due to transcendent influence.

The palaeontological evidence indicating a more or less ascending (but by no means univocal or continuous) order from 'simple' organisms to ever more complex forms has been explained in metaphysical terms by Titus Burckhardt. On the material plane the relatively undifferentiated always precedes the complex and differentiated, since all matter is like a mirror reflecting the activity of the essences ('forms') by inverting it. This explains why the seed precedes the tree and the leaf bud the flower, whereas in the principial order the perfect 'forms' pre-exist (Burckhardt 1974: 144). Or as stated by Aristotle, the order of actual development of things and the order of logical existence are always the inverse of each other (*Parts of Animals*, Book II 646).

The Hellenic philosophical notion that Mind/Intellect (*nous*) and not contingency lies at the origin of the cosmos has been affirmed by a variety of facts drawn from astrophysics, microbiology, and computer technology. Based on their researches in these disciplines, the astronomer Fred Hoyle and the mathematician Chandra Wickramasinghe concluded that the complexity of life on Earth could not have been caused by a sequence of random events, but must have been produced by a transcendent cosmic intelligence (Bakar 2003: 178). In this way is the perennial wisdom of metaphysics confirmed by the provisional findings of science.

9.5.7 Progress and evolution

Viewed from a traditional metaphysical perspective, Darwinism is a by-product of the modernist myth of progress, which conceives human progress in strictly material terms. According to the eminent Sufi philosopher Seyyed Hossein Nasr, several factors contributed to the modern Western belief in progress through material evolution. To begin with, during the Renaissance the Western view of humankind became reduced to the purely human and earthly, instead of the traditional Christian teaching that humans are born in order to become more than human (in Orthodoxy this is expressed in the Patristic doctrine of *theōsis*, i.e. becoming like God). As explained by Nasr, ‘The Renaissance humanism, which is still spoken of in glowing terms in certain quarters, bound man to the earthly level, and in doing so imprisoned his aspirations for perfection by limiting them to this world’ (1981: 45). Shortly thereafter the territorial conquests in the Americas, Africa and Asia brought great wealth into Western Europe, thus stimulating a belief in material progress. Some forms of Protestant theology even associated economic activity with moral virtue, thus contributing to the rise of capitalism in the Western world (Nasr 1981: 45).[34]

The increasing secularisation of Western humankind from the Renaissance onwards led to the transcendent being replaced by the immanent, the spiritual by the material, and belief in the hereafter by a focus on the here and now. It is also interesting to note that the belief in human progress aroused such fervour that it began serving as a pseudo-religion, of which the pernicious nature has been well sketched by Nasr: ‘Perhaps there is no modern ideology which has played as great a role in replacing religion and, as a pseudo-religion, attracting the ultimate adherence of human beings as the idea of progress, which later became wed to

[34] The link between Protestantism (especially Calvinism) and capitalism was postulated by the German sociologist Max Weber in his work *The Protestant Ethic and the Spirit of Capitalism*, first published in 1905. By the late twentieth century the conflation of evangelical Protestantism with material wealth had reached a nadir in the so-called ‘prosperity gospel’, which critics aptly referred to as ‘Cadillac theology.’

evolutionism' (1981: 46). Concomitantly, the Christian teaching on the linearity of historical time became transformed into faith in human progress through historical change, as expounded by Hegel and Marx. Moreover, the rise of fully secularised utopianism during the eighteenth and nineteenth centuries led to an almost messianic zeal to establish a perfect social order in this world, whether through revolution or evolution (Nasr 1981: 46-48).

Of decisive significance in the development of the progress myth was the so-called scientific revolution of the seventeenth century, during which the symbolical world-view still affirmed by Renaissance thinkers such as Ficino, Mirandola, Flamel, Da Vinci and Bruno was replaced by the mechanistic world-view of Kepler, Galileo and Newton, as well as the divorce of matter from mind by Descartes. Thus was created a new science, in which matter was reduced to a mere thing. The Western world-view became mechanistic, and everything could be explained by means of quantitative laws (Nasr 1981: 49). A pioneering role was played in this regard by Galileo, who formulated the principles of the *nuova scienza*, the 'new science', which still hold sway: (i) science is concerned mainly, if not exclusively, with matter; (ii) science has to reduce all things to parts, since it cannot grasp the whole; (iii) all changes in matter are caused by external forces; (iv) science deals only with the 'primary' qualities of things, such as extension, motion, and mass; (v) scientific language is mathematical, based on measurement; and (vi) all theories have to be tested in order to establish their truth or reality (Van Vrekhem 2012: 35). It should be noted that the reductionist view of matter posited by the 'new science' has nothing in common with any of the traditional views, such as the Greek *hylē,* the Sanskrit *Prakriti*, the Arabic *māddah*, or the Latin *materia*, not even among the Hellenic or Indian 'materialistic' philosophers such as the Atomists (Nasr 1981: 49).

The correlation between evolutionism and the progress myth has also been emphasised by Martin Lings. Employing a familiar visual analogy, the English Muslim scholar writes: 'In this context the theories of evolution and progress may be likened to the two cards that are placed leaning one against the other at the "foundation" of a card house. If they did not support each other, both would fall flat, and the whole edifice, that is, the outlook that dominates the modern world, would collapse. The idea of evolution would have been accepted neither by scientists nor by "laymen" if the nineteenth-century European had not been convinced of progress, while in this century evolutionism has served as a guarantee of progress in the face of all appearances to the contrary' (1974: 112). One of the founders of the modern evolutionary synthesis, Julian Huxley, did not limit his view of evolution to biology but expressed it as an all-embracing world-view. In an essay titled *Evolution, Culture and Biology* (1955), Huxley defined evolution as ‘a self-maintaining, self-transforming, and self-transcending process, directional in time and therefore irreversible, which in its course generates ever fresh novelty, greater variety, more complex organization, higher level of awareness, and increasingly conscious mental activity’ (quoted in Dobzhansky 1967: 36). As commented by Edward Larson, ‘For him [Huxley], progress was embodied in the evolutionary process that gave us birth and would carry us ever upward if we let it’ (quoted in Van Vrekhem 2012: 116). This combination of a deficient notion of evolution with a mythical ‘progress’ helps to explain the messianic zeal with which the Neo-Darwinists habitually advocate their case and attack opposing viewpoints.

Furthermore, it is no coincidence that the evolutionist theory arose in the nineteenth century, which marks the peak of the eclipse of metaphysical tradition in the West, as Nasr stated in his Gifford lectures in 1981 (published as *Knowledge and the Sacred*). Among the few exceptions to this rule count Goethe, Taylor, Blake and Emerson (Bakar 2003: 163). In the absence of metaphysical thought in the West, theological notions such as the immutability of species, divine archetypes, creation, and design or purpose in nature, all became understood (or rather misunderstood) in their popular formulations. For instance, the theological doctrine of creation out of nothing (Latin *creatio ex nihilo*) was read literally and attacked as such by the evolutionists, whereas the metaphysical meaning thereof is creative emanation. Both *creation ex nihilo* and creative emanation are true but at different levels, as remarked by Frithjof Schuon, with the metaphysical serving to explain the theological (Bakar 2003: 163-164).

The ambivalence of the fact that the twin notions of progress and evolution (the latter in its Darwinian sense) arose within a Judeo-Christian cultural context has been recognised by Theodosius Dobzhansky. On the one hand, Christianity is the most history-conscious among the world religions, and is in that sense ‘evolutionistic.’ On the other hand, neither Christianity nor Judaism taught any kind of progressive evolution towards a perfect state, due to their belief in an original state of perfection which was followed by a fall with catastrophic effects (Dobzhansky 1967: 37-38). During the nineteenth century the evolutionary ideas of Kant, Herder and Fichte culminated in the system of Hegel, which viewed history as the progressive manifestation of the Spirit. This was followed by Marx’s replacement of Spirit by economic forces, especially production. In a remarkable coincidence, Marx and Darwin postulated their evolutionary theories (of society and life, respectively) at approximately the same historical juncture (Dobzhansky 1967: 38).

9.5.8 The struggle for existence

Darwin’s theory was to a large degree an extension of Malthusianism, taking over its leading idea of a ‘struggle for existence.’ Further antecedents of Darwinism are mentioned by Francis Yockey, beginning with Arthur Schopenhauer who depicted nature as pervaded by a struggle for self-preservation, with the human mind as a weapon in the struggle and sexual love acting as unconscious mechanism of selection. A theory of descent had also been suggested by Herbert Spencer, who coined the slogan ‘survival of the fittest’ (Yockey 1962: 67-68). Yockey pointed out that the religious background of Darwinism was Calvinism, which in an adapted form had been the national religion of England for hundreds of years. In Calvin’s teaching the ‘fit’ is called the elect of God, and what Darwin did was to replace election by God with selection by nature (Yockey 1962: 68). Moreover, the principle of survival of the fittest expresses a self-evident truth, since it means the survival of those who survive, i.e. the fittest (Berg 1969: 66). The Darwinian slogan ‘survival of the fittest’ could therefore be viewed as a biological case of circular reasoning, or *petitio principii* (begging the question).

The Darwinian notion of a struggle for existence was rejected by Friedrich Nietzsche on the grounds of being more of an assumption than a fact. In *Twilight of the Idols*, the German philosopher admitted that such a struggle does occur, but as an exception. He adds, ‘The general condition of life is not one of want or famine, but rather of riches, of lavish luxuriance, and even of absurd prodigality – where there is a struggle, it is a struggle for power. We should not confound Malthus with nature’ (2007: 55). Yockey concurred that there is in reality no struggle for existence in nature, and added that this notion is a projection of capitalism onto the animal world. The rule in nature is that of abundance: enough plants for the herbivores, and enough herbivores for the carnivores (1962: 69-70). And according to Lord Northbourne, the notion of a universal struggle for existence is highly anthropomorphic, being a projection of the human state of human onto the world of nature. The British traditionalist adduces the beauty of flowers in this context: ‘The floral picture at any rate manifests a joyous superfluity that accords ill with any conception so grim as that of a universal struggle for existence as the influence above all others that made that picture what is is, and has conferred on us the inexplicable and gratuitous benediction of flowers’ (1995: 92).

9.5.9 Utility versus teleology

During the nineteenth century the doctrine of utilitarianism, according to which the maximisation of utility (or happiness) was the ultimate purpose of life, was postulated by English thinkers such as Bentham and Mill. Simultaneously the scientific disciplines of biology and geology became dominated by English thought, Oswald Spengler remarked. Examples thereof are Lyell on the formation of geological strata and Darwin on the origin of species (Spengler 1991: 230-231). However, instead of the mechanisms of catastrophes and metamorphoses postulated by some of their predecessors, ‘they put a methodical evolution over very long periods of time and recognise as causes only scientifically calculable and indeed mechanical-utility causes’ (Spengler 1991: 231). Moreover, Spengler argues, there is no evidence that humans evolved towards greater utilitarian fitness. Instead, the human life-form, like all the others, originates in a sudden mutation (*Wandlung*). Spengler contends further that if Darwinism was correct there could be neither defined earth-strata nor specific animal-classes, but only a single geological mass and a chaos of living forms left over from the struggle for existence. Instead, all the evidence points to repeated profound and sudden changes in the being of plants and animals. Therefore it has to be admitted that the origins of the Earth, of life, and of free-moving animal are epochs (in the sense of turning points) and thus mysteries (Spengler 1991: 232-233).

In his summary of the theory of natural selection, titled *Darwinism* (published in 1889), Alfred Wallace contended that humans differ from other animals not only in degree, but also in kind. The English naturalist reasoned that human activities such as mathematics, abstract reasoning, art and music cannot be explained in terms of natural selection or utility, but instead serve as evidence of a spiritual essence capable of further development under favourable conditions (Flannery 2011: 20-21). Wallace questioned whether the Darwinian theory can account for the origin of the mind: what relation does an improvement of the mathematical faculty have to the struggle for life for its possessors, or the survival of its tribe, nation or race? He concluded that in the absence of such effects, mind cannot have been produced by natural selection. Arguing along similar lines against the Darwinian notion of utility, the philosopher of science William Thompson posed the question why humans evolved a brain far more complex than that needed for survival (Flannery 2011: 213, 215).

In his turn Francis Yockey argued that the utilitarian aspect of Darwinism is subjective, since the utility of an organ is relative to the use made of it. A slowly evolving organ would be disadvantageous to the organism until it has been perfected, which could take countless generations according to Darwin (1962: 72). According to Yockey, the primacy of the spiritual sphere inverts the Darwinian materialism regarding utility. Even a lack of something can be utile, for a lack of one sense can develop others. Physical weakness can stimulate intellectual development, as has often been observed. An absence of one organ stimulates other organs to compensate, for example in endocrinology (Yockey 1962: 73). The assumption of utility or other visible causes for biological phenomena has no support in actuality, Oswald Spengler added (1991: 231-232).

It appears that Darwin was ambivalent concerning teleology, if not confused. On the one hand, he admired the beauty in nature, both sensible (e.g. the colours of birds) and intelligible (e.g. the mutual adaptation of bodily parts one to another). Darwin ascribed sensible beauty to utility, notably in the phenomenon of sexual selection (Gilson 2009: 97). He also declared the beauty of plant parts, notably those of orchids, to be unparalleled. Darwin thus approaches the notion of final causality, since the beauty of adaptations is a means to an end, in terms of which such adaptations are intelligible only from the point of view of their final result (Gilson 2009: 98). On the other hand, in his *Autobiography* the English naturalist declared that the argument from design, i.e. teleology, has been replaced by the law of natural selection: ‘There seems to be no more design in the variability of organic beings and the action of natural selection than in the course in which the wind blows. Everything in nature is the result of fixed laws’ (quoted in Swift 2002: 81). And the liberal philosopher John Stuart Mill remarked in a review of the *Origin* that Darwin had literally denied the intelligibility of nature (Fuller 2008: 88). Evidently, Darwinism has been anti-teleological from the outset, with no allowance made for final causality in the organic realm.

Regrettably, through the apparent victory of the modern evolutionary synthesis in the life sciences, the study of life (Greek *bios*) has been reduced to the study of purely materialistic chemical processes. Whereas Weismann and De Vries viewed their ‘biophores’ and ‘pangenes’ as material particles that were yet carriers of life, ‘progress’ in biochemistry led to the notion of elementary living particles falling into disuse (Van Vrekhem 2012: 120-121). Nonetheless, as argued by Georges van Vrekhem, ‘that life differs from matter, and that organisms cannot live without this different element, is also a fact. A dead bird does not move, a living bird flies away’ (2012: 121). This reasoning by a leading Belgian disciple of Aurobindo reminds one of Aristotle’s insistence on the priority of form over matter, which in the case of living things entails a priority of the soul over the body. Ultimately, in evolution (as traditionally understood) there is room for matter and life and mind, but in Darwinism there is not (Van Vrekhem 2012: 122).

9.5.10 Materialism versus levels of being

The Swiss-born philosopher Frithjof Schuon criticised modern evolutionism in a number of his works. The 'evolutionist error', as he calls it, is rooted in the materialists' belief that only the horizontal and natural exist, while the vertical and supernatural are rejected. Thus, 'Instead of conceiving that creatures are archetypes "incarnated" in matter, starting from the Divine Intellect and passing through a subtle or animic plane, they restrict all causality to the material world, deliberately ignoring the flagrant contradictions implied by this conceptual "planimetry"' (Schuon 2001: 1). That is to say, the evolutionists reject all formal and final causality, as we noted earlier, since these pertain by definition to supra-material factors.

The evolutionist doctrine that the origins of life, sentience, and intelligence can be explained in materialistic and mechanistic terms only represents a blatant denial of all intelligible reality. In the traditional metaphysical understanding there are various degrees of reality, all grounded in the Divine Principle. In an ascending order, reality consists of the material or sense-perceptible level; the subtle or psychic level; the intelligible or supra-formal level; Being as ontological Principle; and finally the Absolute, which is Beyond-Being (Bakar 2003: 169-170). Accordingly, life originates not in the physical world but in the transcendent realm.

A related criticism relates to the evolutionists' ignorance concerning the various levels of being. That is to say, 'between the organism that simply lives, the organism that lives and feels, and the organism that lives, feels and reasons, there are abrupt transitions corresponding to an ascent in the scale of being and that the agencies of the material world cannot produce transitions of this kind' (Bakar 2003: 179). These three levels of being evoke Aristotle's levels of soul, namely the nutritive, the sensitive and the rational. Between these levels of soul, and hence of being, there are ontological discontinuities that cannot be reduced to material causes.

The modern theory of evolution asserts that, under certain conditions, matter produces life and animate matter produces spirit. It is further averred by proponents of materialist evolution that the final conditions under which animate matter produces spirit are located in the function of the brain (Yannaras 2004: 73). In his *Postmodern Metaphysics*, Christos Yannaras posits a hermeneutic challenge to the theory of evolution in the discontinuity from inanimate to animate matter, and from brain function to specifically human spiritual activity (2004: 74-75). It is further argued by the Greek philosopher that the claim of random and accidental genesis of animate matter does not leave the (materialist) theory of evolution with logical space. Another gap in the logical space of this theory is made by its contradictory linking of chance and entelechy (Yannaras 2004: 76-77). Moreover, Yannaras reasons, 'The probabilities of continuous evolution from the brain functions of animals to the spiritual capabilities of human beings presuppose an exemplary space for possible correlations which becomes zero when the fact of human *freedom* requires a causal explanation.' And this freedom is not limited to the power of making choices, Yannaras explains, but pertains above all to 'the power of human existence to define itself and its practice.' Thus, by limiting natural science, philosophy separates the logical space of the theory of evolution from the latter's claim to explain the meaning of the world and of existence (Yannaras 2004: 82).

9.5.11 Transformation versus manifestation

The implications of the foregoing reasoning for the biological notion of species and their supposed transformations have been outlined by Osman Bakar in his survey of scientific, metaphysical, and religious-philosophical criticisms of modern evolutionism. Initially a species is an idea in the Divine Mind, that is to say an archetype beyond individual limitations and change. The first manifestation of a species occurs on the subtle level, where the transcendent form is conjoined with a subtle proto-matter, 'this "form" referring to the association of qualities of the species which is therefore the trace of its immutable essence' (Bakar 2003: 170). This 'vertical' genesis of species as understood in traditional metaphysics is clearly opposed to the 'horizontal' genesis of species from a single cell as postulated in modern biology. Therefore, since each species is an independent reality which differs qualitatively from all other species, it is impossible for a species to 'evolve' and become transformed into another species. However, as Bakar admits, within a particular species variations can occur, these being none other than the actualisation of pre-existent possibilities without affecting their essential form (2003: 170-171) – that is to say, micro-evolution.

Since the notion of evolution in its classical sense arose in the domain of metaphysics, it necessarily follows that any biological theory striving to present an alternative to Darwinian evolutionism has to be metaphysically based. Referring to the monumental work of René Guénon, Ananda Coomaraswamy and Frithjof Schuon in restating the fullness of the metaphysical tradition during the course of the twentieth century, Osman Bakar stated its relevance for evolutionary biology as follows: ‘In a sense we can speak of traditional metaphysics as a whole as an implied criticism of evolution and all its generalizations and implications inasmuch as metaphysics is a *theōria* or vision of Reality and evolutionism is its modern substitute’ (2003: 167). Accordingly, metaphysics attacks the modern theory of evolution at its root, and not tangentially – that is to say, metaphysical criticism is radical (from *radix*, Latin for root). This approach enabled Schuon to criticise evolutionism as a materialist parody of creative emanation: ‘In the place of the hierarchy of invisible worlds, and in the place of creative emanation... one puts evolution and the transformation of species, and with them inevitably the idea of human progress, the only possible answer to satisfy the materialists’ need of causality’ (quoted in Bakar 2003: 169).

A contemporary American scholar working within the metaphysical tradition, James Cutsinger, presented a number of reasons in his essay *On Earth as it is in Heaven* for rejecting Darwinian evolutionism (2007: 5-9). To begin with, the theory of natural selection has from the outset been presented as a scientific theory, and is as such tentative and provisional. In the second place, Darwinian transformism is explicitly limited to the material level, which is the least real dimension of the cosmos and hence the least intelligible. Third, by striving to explain the more by the less, the transformist cosmogony implies that the lowest explains most of all, and that ultimately something is derived from nothing. Thus is obtained a materialistic and atheistic parody of the Christian doctrine of God’s creation from nothing, namely the creation of something *from* nothing *by* nothing. In the fourth place, by mistaking temporal succession for ontological causation, transformism succumbs to the logical fallacy of *post hoc*, *ergo propter hoc* (Latin: after this, therefore because of this). In the metaphysical understanding, the order in which the various species of plants and animals have been disclosed in matter over time is the reverse of their supra-temporal order as archetypes or Ideas. It is therefore incorrect to state that mammals are derived *from* reptiles, Cutsinger remarks, but (in a sense) they are derived *through* them. Fifth, the Darwinian notion of evolution is blind to the fundamental distinction between form and shape. Whereas a species is dependent on shape, and shape is a function of surface, form denotes the ontological link between an organism and its intelligible archetype. Thus, ‘A truly adequate cosmological explanation of the world is an explanation of forms and their hierarchical order, and of That which they wish to express’ (Cutsinger 2007: 9). Finally, Darwinism fails to account for the reality of mind (*nous*) by reducing it to the result of the operation of physical, chemical and/or biological forces. In reality, mind transcends all natural processes, since it proceeds from the

Source of all reality. Cutsinger concludes that the Darwinian theory of evolution reflects all the characteristics of the modern scientific project, by being empiricistic, materialistic, reductionistic, historicistic, nominalistic, and relativistic (2007: 9).

However, Cutsinger adds, none of these objections to Darwinism prevents the metaphysician or theologian from recognising the sequential appearance of life-forms on the Earth, as well as the ongoing variability in the physical constitution of plant and animal species. That is to say, the empirical evidence provided by the geological record, the techniques of radiometric dating, and the results of artificial breeding in no way repudiates the traditional Indo-Hellenic cosmology and metaphysics. Or, as succinctly remarked in this context by Frithjof Schuon, facts are always compatible with principles (Cutsinger 2007: 10, 22).

9.6 Conclusion

We have surveyed a wide range of objections to the modern theory of evolution. However, one should guard against the all-too-human tendency of throwing out the baby with the bath-water, colloquially speaking. We therefore concur with David Swift that Darwin should be credited with recognising the importance of variations, natural selection, and evolution within limits (i.e. micro-evolution).[35] First, it is recognised that species possess genetic variability which has the potential of leading to distinct varieties, subspecies, and ultimately new species. Second, natural selection acts upon randomly occurring variations by perpetuating those genetic combinations beneficial to the organism, while rejecting those which are detrimental. Third, due to the foregoing mechanisms evolution becomes not only probable but certain. Species are therefore not fixed entities as had earlier been believed (Swift 2002: 381-382).

Nevertheless, Darwin (and his contemporary followers who apparently choose to ignore the genetic evidence) erred (and still do) in summarily extrapolating from micro-evolution to macro-evolution, since this argument does not consider the origin of variations or the limits to variability. In other words, while Darwinism provides a feasible explanation of micro-evolution, it fails as an explanation of macro-evolution for which the production of new genetic material is required. We contend that macro-evolution is better explained in the light of lawful, directed, and convergent evolution, which will be discussed in the next chapters.

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[35] Keeping in mind that this assessment by Swift follows upon hundreds of pages of criticism of the modern evolutionary theory, on the grounds of molecular biology, genetics, and the fossil record.

10: Evolution according to natural law

10.1 Historical background

An early exponent of organic evolution as a process directed by natural law was Robert Chambers in his *Vestiges of the Natural History of Creation*, published anonymously in 1844.[36] In this epochal work the Scottish writer argued that to ascribe the production of the progenitors of all existing species to personal exertion by God is to anthropomorphise the creative power of the Deity (Denton 1998: 269). As argued by Chambers: 'Some other idea must then be come to with regard to the *mode* in which the Divine Author proceeded in the organic creation... We have seen powerful evidence, that the construction of this globe and its associates, and inferentially of all the other globes of space, was the result not of any immediate or personal exertion on the part of the Deity, but of natural laws which are expressions of his will... More than this, the fact of the cosmical arrangements being an effect of natural law, is a powerful argument for the organic arrangements being so likewise, for how can we suppose that the august Being who brought all these countless worlds into form by the simple establishment of a natural principle flowing from his mind, was to interfere personally on every occasion when a new shell-fish or reptile was to be ushered into existence on *one* of these worlds? Surely the idea is too ridiculous to be for a moment entertained' (quoted in Denton 1998: 269-270; italics in the original).

Instead of such ongoing Divine intervention, Chambers suggested that the properties of the elements at the moment of their creation adapted themselves to an infinity of useful purposes. Since both the cosmos and the world of life are produced by natural laws, Chambers viewed all reality, biological and physical, as one immense interconnected Divine artifact (Denton 1998: 270). Moreover, he anticipated an ongoing biological debate by postulating an analogy between embryology (or rather ontogeny, i.e. the development of an individual organism from an egg cell) and phylogeny (i.e. the development of a species from an original progenitor), since both processes are determined by the laws of nature. Although Chambers was vehemently attacked by the Victorian scientific establishment, his work appears more relevant than ever in the light of today's cosmology and molecular biology (Denton 1998: 270-271).

According to the Platonic cosmogony as evoked by Richard Owen in *On the Nature of Limbs*

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[36] Although not a professional scientist, Chambers was erudite and had a solid grasp of prevailing scientific issues (Swift 2002: 76).

(1849), all the basic recurrent forms of both the organic world (the pentadactyl design of vertebrate limbs, the body plans of major phyla, the forms of leaves, etc.) and the inorganic world (atoms, crystals, etc.) represent material manifestations of a finite set of immaterial archetypes. In other words, just as God assembled the heavenly bodies through natural laws, so also is the organic realm the result of natural laws (Van Vrekhem 2012: 65). An indisputable instance thereof is the law of formation, duration and dissolution, which in the organic realm acts as the law of birth, life and death. Lord Northbourne adds, ‘It is applicable to all systems, from man to amoeba, and from spiral nebula to atom’ (1995: 30). It is noteworthy that a lawful account of the physical world is widely accepted today for the inorganic realm; for example, the atom building rules, the laws of crystallography, and the laws of chemistry (Denton 2002: 327). That the same laws apply to the inorganic and organic realms is a necessary corollary of the metaphysical principle that the whole of the sensible world receives its being from the intelligible world in which it participates.

After the publication of Darwin’s theory of natural selection in 1859 the Platonic cosmogony was more or less discarded. The machine or artefact became the new model of organic form, contingency replaced necessity, and natural selection replaced natural law (Denton 2002: 328). It should be noted that Darwin recognised the existence of natural laws, as we read in the closing pages of the *Origin*. The whole organic realm has been produced by the operation of laws ‘impressed on matter by the Creator’, the English naturalist affirms. These laws are then enumerated as follows: growth with reproduction; inheritance; variability due to external conditions, as well as use and disuse; a ratio of population increase leading to a struggle for life; and ultimately natural selection, which entails both the divergence of character and the extinction of unfit forms (*Origin*, Chapter 14; 1998: 368-369). However, Darwin’s conception of natural law appears to be of a purely mechanical nature.

It is ironic, Michael Denton remarks, that the Darwinists have adopted the same metaphor used by their creationist opponents (2002: 329). Both groups view organic order as contingent and artifactual, like the order of a machine created either by God or a blind watchmaker (the title used by Richard Dawkins for one of his books). The artifactual metaphor of organic form inaugurated the era of modern biology and changed the whole explanatory framework of biological science. This was a revolutionary change, Denton asserts, in which the metaphor of the crystal was replaced by that of the watch. Accordingly, the entire organic realm came to be understood as a tiny, finite set of all possible forms, drawn by selection during the evolution of life on Earth from a potentially infinite set. This mechanistic notion implies that any life on other planets has to very different from terrestrial life (Denton 2002: 329).

In contrast, non-Darwinian evolutionary theory asserts that since organic forms arise due to the laws of physics, the whole evolutionary pattern has to be conceived as pre-determined by natural law. Thus Owen wrote in his *Anatomy of Vertebrates* (1866) that the path of evolution had been pre-ordained due to an innate tendency by which nomogenously (i.e. generated by law) created protozoa have risen to higher forms. Moreover, because adaptations are *ad hoc* functional modifications of primal patterns given by natural law and not contrivances designed by God, organisms cannot be expected to exhibit perfect adaptations (Denton 2002: 327-328). With this ingenious argument Owen affirmed both the transcendent origin of life and the reality of imperfect adaptations.

The first comprehensive scientific assault upon Darwin’s theory of organic descent by means of natural selection came from Lev Berg, whose *Nomogenesis, or Evolution determined by law* was published in 1922. In its 400-odd pages the Russian zoologist not only took Darwin’s theory to task, but simultaneously developed an alternative theory of evolution, which he termed nomogenesis (from the Greek *nomos* = law, and *genesis* = origin). The introduction to the English translation published four years later was written by D’Arcy Thompson, whose monumental work we mentioned in an earlier chapter. A further English edition of *Nomogenesis* was published in 1969, to which Theodosius Dobzhansky contributed the foreword. As explained by the eminent Neo-Darwinist, ‘nomogenesis is one of the autogenetic theories of evolution, which postulate that evolution is an unfolding of pre-existing rudiments or potentialities rather than a series of adaptive responses of living species to their environments.’ Dobzhansky adds that Berg strove to avoid the pitfalls of vitalism by asserting that intrinsic agencies in the chemical structure of protoplasm compel an organism to vary in a determined direction, even if it leads to its destruction (Berg 1969: x). That is to say, both variation and speciation occur primarily due to internal factors.

The following evidence count in favour of lawful evolution, Berg declared: (i) facts from palaeontology and comparative anatomy; (ii) the phenomena of convergence, parallelism, and analogous variations; and (iii) the process of individual development, i.e. ontogeny (1969: 111). We will now consider arguments presented by Berg and more recent scientists.

10.2 The origin of adaptations in organisms

It is noted by Berg that adaptations facilitating purposive acts presuppose both adequate structure and adequate function, that is, the capacity to utilise a given organ. Exceptions to purposive reactions that are found among insects, such as the flight of moths towards fire, the extermination by the female of her progeny, abortive regeneration, or anaphylaxis (i.e. a state of hyper-susceptibility which is the reverse of immunity), do not invalidate the general rule that organisms respond to stimuli in a purposive manner. It is further recognised that organic characteristics which are neutral in relation to the life or death of the individual, arise in a purely mechanical manner. This occurs in obedience to physical and chemical laws, and thus without the intervention of chance (Berg 1969: 3). Berg's reference to the mechanical origin of existentially neutral characteristics evokes Aristotle's recognition that certain phenomena, such as the colour of a person's eyes, are to be explained by material and efficient causes only, without the operation of final causality (*Generation of Animals*, 778a-b).

Some thinkers have suggested that the origin of purposive adaptations could be ascribed to a fortuitous combination of circumstances. This view was first conceived by Empedocles and fully elaborated by Darwin who called it natural selection, while Spencer called it survival of the fittest. Darwin's theory of natural selection claims that the origin of purposive characters is due to accidental usefulness, and that a gradual perfection in organisation, or progress, results from survival of the fittest (Berg 1969: 4-5). However, Darwin's theory of selection fails to account for the *origin* of characters. It only attempts to explain why individuals with useful characters survive and become more perfect (Berg 1969: 14-15). In his critical assessment of Berg's theory, Ernest MacBride agrees that natural selection is a purely negative agent. To be more precise, 'What the belief in natural selection as an efficient agent really implies is the constant occurrence of small inheritable variations in all directions. This assumption is directly contradicted by every relevant experiment devised to test the point. *If the conditions are kept constant* selection is powerless to effect progressive change' (MacBride 1927: 32).

Is organic adaptation driven by accident or purpose? Darwin assumed that the variability of organisms is so great that chance, in adapting characters, will always select an accidental variation which may prove useful. In other words, selection operates on accidental variations (Berg 1969: 37). This notion implies that every purposive adaptation possesses a very long history, in which natural selection weeded out those individuals that lacked the necessary qualities. But in reality, Berg counters, many adaptations are displayed spontaneously and immediately, without any intervention by natural selection (1969: 37-38). This is illustrated by examples from both the plant and animal kingdoms, such as the phenomenon of graft hybrids. In the grafting of various pairs of plant species, for example tomato (*Solanum lycopersicum*) and nightshade (*S. nigrum*), groups of cells grow concordantly and produce stems, leaves and flowers consisting of tissues of both the scion and the stock. It therefore appears as if an 'inner regulating principle' had created hybrid forms out of parts of the organs of two different organisms (Berg 1969: 38, 40). This scientific argument reminds one of the Hellenic philosophical notion of intelligible reason-principles (*logoi*) indwelling all existing things.

It has similarly been observed that inter-species transplantations of body parts of types as diverse as newts, hydras, earth-worms, moths and frogs, have produced a single organism with characteristics of both species, which respond in a purposive manner to stimuli and in some cases have even reproduced. Berg (1969: 42) concludes, 'As in their former (phylogenetic) experience the individuals selected for grafting or transplantation had never encountered anything of the kind, it obviously follows that the capacity for reacting in a purposive manner is commonly developed, not as a result of natural selection, but owing to that capacity being originally inherent in the organism.' A further illustration hereof is the phenomenon of artificial immunity, when an organism acquires the capacity to react in an efficient manner to substances previously unknown to it (Berg 1969: 43).

According to Immanuel Kant the races (i.e. subspecies) of *Homo sapiens* are derived from a common genus through the influence of climatic conditions. Humans thus appear to possess an inherent capacity to react in different ways to a varying climate, Berg contends (1969: 15). The variations in skin colour among the human races has been explained in terms of genetic diversity and natural selection by David Swift. Since not all races living in sunnier locations have a dark skin (e.g. the native Americans in the Tropics, as Dobzhansky had noted), the traditional view linking colour with the effect of sunlight is deficient.[37] Instead, the early *Homo sapiens* probably had more genetic variability, enabling it to produce a range of skin colour. Due to their worldwide migrations, different gene combinations have been selected in different populations to suit their particular environment. This resulted in a fair skin to those

[37] In this view, the species *Homo sapiens* originally had a pigmented skin as protection against the intense rays of the tropical sun. Those subspecies which migrated to colder climates, such as the yellow (or Mongoloid) and white (or Caucasoid) races, lost their pigmentation in varying degrees; whereas those that remained in the Tropics, such as the black races (Negroid and Australoid) retained or augmented it (Campbell 1970: 3).

living in less sunny parts to facilitate the production of vitamin D, and a dark skin to those in more sunny parts as protection against ultraviolet light (Swift 2002: 254).

However, from a metaphysical viewpoint the primary human races could be viewed as manifestations of the cosmic tendencies (Sanskrit *gunas*) of *sattva*, *rajas*, and *tamas*. *Sattva* is related to fire and is thus an ascending tendency; *rajas* to water and thus expansive; and *tamas* to earth and thus descending or solidifying. In terms thereof, Frithjof Schuon argued, the white race is a manifestation of *sattva*, the yellow race of *rajas*, and the black race of *tamas*. This differentiation should not be understood in an absolute sense, since each of the *gunas* also combines with the other two. For example, fire and water meet in the element of air, which thus displays the qualities of lightness (*sattva*) and mobility (*rajas*). As for earth, it not only possesses heaviness (*tamas*) and fertility (*rajas*), but also the aspect of luminous 'crystallinity' (*sattva*), as found in minerals (Schuon 1982: 50-52). Furthermore, since all authentic religion is based on metaphysical precepts (it was even declared by Oswald Spengler that religion is metaphysics and nothing else; 1991: 288), it follows that the various human races possess their own inherent religious concepts which are suited to their racial mentality (i.e. their dominant *guna*). In his thoughtful work on the relation between race and religion, C.G. Campbell remarked further that the more racial groups differ in their origins, the more they will tend to differ in their religions. This religious differentiation will persist, albeit in modified forms, through contact with other religions (1970: 2-3). In our era of globalisation such inter-religious contact has become commonplace, leading to various strategies for the accommodation thereof, such as the notion of religious pluralism.

10.3 Law, chance, and design

What is natural law? In nature, Berg asserts, the same phenomena are repeated when the same conditions recur. Natural law is therefore the probability of a future occurrence of such repetition (Berg 1969: 133). Empirically speaking, natural laws pertain to numerical regularities within the realm of measurable phenomena. In terms of the modern scientific project, natural phenomena should be explained by means of the simplest laws possible. These laws are viewed by many scientists as final and universal (Thompson 1981: 134-135). However, the assumption that nature always makes use of the simplest means is an *a priori* fallacy, as had been argued by John Stuart Mill in his *System of Logic* (Berg 1969: 20). Moreover, our knowledge of the laws of nature is by no means final. As remarked by the physicist David Bohm,[38] 'the possibility is always open that there may exist an unlimited variety of additional properties, qualities, entities, systems, levels, etc. to which apply correspondingly new kinds of laws of nature' (quoted in Thompson 1981: 134-135).

It was emphasised by Lev Berg that nomogenesis entails development according to definite laws, and not development due to chance as was believed by Darwin. Nomogenesis is therefore opposed to Darwin's tychogenesis (Berg 1969: xvii, 22). The latter term is derived from the Greek *tychē*, meaning luck or chance (L&S 722). That chance plays a subordinate role to law in the organic realm has also been asserted by Pierre Grassé. In his *Evolution of Living Organisms* (1977) the French zoologist writes, 'It is neither randomness nor supernatural power, but laws which govern living things; to determine these laws is the aim and goal of science, which should have the final say' (quoted in Davison 2006: 5). And since our universe is subject to definable laws, it excludes anything that is incompatible with those laws. The law-regulated cosmos could thus be viewed as a system of mutually compatible possibilities which are not assembled by chance. Therefore, things exist because they are compatible with the conditions of that particular system, such as form, number, time, space and energy (Northbourne 1995: 113, 117).

Building on the dictum of Ludwig Wittgenstein in his *Tractatus Logico-Philosophicus*[39] that a proposition determines a place in logical space, Christos Yannaras depicts the logical place of chance in cosmology and biology. To begin with, 'Chance fundamentally reflects an accident-coincidence to which questions of causality (whence?) or mode (how?) or object-purpose (for what?) cannot be put. That is to say, what has come about by chance is not subject to the constitutive elements of meaning. For this reason the fortuitous is also synonymous with the senseless and the inexplicable' (Yannaras 2004: 67, 187). It is therefore a logical contradiction to claim that the world is a product of chance, the Greek philosopher concludes. Furthermore, by attributing 'the generation and formation of matter, its evolutionary changes, the activated functionality of the world, to unexplained accidents and nonsensical coincidences', the proposition of chance is actually a pseudo-proposition (Yannaras 2004: 67-68).

Yannaras furthermore relates the impossibility of chance as a hermeneutic principle to the

[38] It is noteworthy that Bohm employed insights from Buddhist cosmology, such as the notion of dependent co-origination (Sanskrit *pratitya-samutpada*), in his work (Krüger 2007: 154-155).

[39] Arguably the most influential work of Western philosophy in the twentieth century (Krüger 2007: 150).

logic of probabilities. He argues that ‘If the universe has a beginning in time, the logic of probabilities cannot explain this beginning. Which means that the fortuitous and accidental, as a function of the probable, cannot be a causal principle of the universe before circumstances existed to give this or that degree of probability to the realisation of the actual universe.’ Therefore, ‘As a causal and functional “principle” of the world, chance is a hermeneutic principle as nonsensical as any mythical explanation of the world’ (Yannaras 2004: 69). In opposition to chance, which has zero logical space and as such is destructive to both philosophy and science, Yannaras posits indeterminacy as a meaningful hermeneutic principle. Indeterminacy refers to the *whence* and *how* and *for what* of specific facts in the realms of sub-atomic space and the biosphere. However, these facts are not predictable – although they are in harmony with certain first principles, they are not constituted by these principles (Yannaras 2004: 70). That is to say, while the notion of indeterminacy recognises the unpredictability of events in the organic realm, it should not be confused with chance.

Does the existence of chance refute causality? Absolutely not, Berg replies, if causality is understood as conformity to law (1969: 21-22). This reflects Aristotle’s view that chance events are not anti-teleological in nature, but rather act as incidental causes in the attainment of purpose (*Physics*, Book II). Darwin himself acknowledged that variations arise only apparently due to chance (*Origin*, Chapter 5; 1998: 102), and in a later work he also wrote that each modification is subject to the law of causality (Berg 1969: 23). Therefore, when Daniel Dennett averred that the design in nature recognised by Darwin is ‘a wonderful wedding of chance and necessity’, he is committing an act of doublethink, Michael Flannery aptly remarks, since design as chance is not design (2011: 47).

In the pre-Darwinian era the proponents of natural theology based their arguments for design on the observed complexity of morphological structures such as the human eye. However, this teleological argument was undermined by the Darwinian notion that the phenotype is determined by the genotype. In terms thereof, genes are the source of useful variations which are then acted upon by natural selection in order to facilitate the adaptation of organisms to their mode of life. However, David Swift pointed out, the recent discoveries of molecular biochemistry have in their turn undermined the Darwinian view that even macro-evolutionary changes can be explained in terms of variation and selection. For example, the substantial complexity of biological macromolecules could not possibly have arisen through chance processes, let alone the integrated action of many such molecules in any organic system.

Complexity is therefore not incidental, but an essential aspect of molecular biology. Swift concludes, ‘So the argument for design, or purpose, or teleology in biology is weak at the morphological level. But at the molecular level we have an unequivocal case... In summary, as originally formulated, even going back to Aristotle... the argument for design was essentially subjective; but what I am suggesting here is an objective assessment based on the functionality and improbability of biological structures at the molecular level’ (2002: 216-218). Thus is the philosophical notion of teleology, i.e. final causality, confirmed by the evidence of molecular biology.

The immense complexity of the organic realm is evident even from one of the smallest and simplest living organisms, the unicellular bacterium *Escherichia coli*. Although it is around 500 times smaller than the average cells of higher plants and animals, this organism contains between 3 000 and 6 000 different types of molecules, as well as between 2 000 and 3 000 different kinds of proteins. Each of the latter is built up from 20 different amino acids, and a typical protein in an *E. coli* contains around 300 subunits of these amino acids (Thompson 1981: 111-112). The extreme improbability of even the simplest self-reproducing systems having arisen by chance has been mathematically demonstrated by Fred Hoyle and Chandra Wickramasinghe in their *Evolution from Space* (1981). These scientists calculated the odds of *E. coli* being constructed through random interaction as $10^{40\,000}$ to 1. The 4.5 billion years allowed by the estimated age of the Earth would therefore be much too brief to allow such an event occurring (Thompson 1984: 35). As a matter of fact, the improbability of any biological macromolecules being constructed at random has been convincingly argued by David Swift. For example, the chances of the small protein cytochrome *c* with its 104 amino acids being produced randomly has been calculated as 1 in 10^{40}, whereas the entire age of the universe (around 15 billion years) is less than 10^{18} seconds (Swift 2002: 136-138).

Since the middle of the twentieth century the life sciences have become dominated by the molecular paradigm, in which the central dogma (as Francis Crick labelled it) is the flow of information (Hewlett 2006: 176). It is now axiomatic in molecular biology that all the information required to specify a cell is contained in its DNA. In the Darwinian conception, this coded information cannot be changed except through random mutations. However, the enormous complexity of genetic information discounts the possibility of it having arisen by chance. If we again consider the very simple *E.coli* bacterium, it has been calculated that its single cell contains up to 5.5 million bits of genetic information. Microscopic studies have found that vertebrate cells are between 20 and 50 times more complex genetically than *E. coli*, which means that they should contain coding for at least 20 to 50 times as many kinds of protein molecules as in *E. coli* (Thompson 1981: 112-113). Furthermore, genetic 'programming' entails an interacting system of structural and regulatory genes. Whereas a structural gene defines a specific structural element of a living organism, a regulative gene controls the timing and ordering in the expression of other genes. It is highly improbable that complex organic structures could have arisen due to random mutations in either structural or regulatory genes (Thompson 1981: 198, 201).

Continuing his argument regarding the complexity of living organisms, the mathematician Richard Thompson outlines the following hierarchy of structure and function. First, the chemical reactions involved in cellular metabolism (e.g. the metabolic interactions of *E.coli*) are so intricate that they require a complex system of logic comparable to sophisticated computer programmes. Second, the morphology of cells even among simple organisms such as algae and protozoa are highly intricate, requiring complex molecular machinery for its construction. Third, the varieties of cells constituting the tissues of higher organisms (e.g. muscle, nerve, bone, and blood cells) require high levels of genetic coding, including instructions for their development during the growth of the embryo. Fourth, the structural and functional complexity of the organs in higher plants and animals (e.g. the disease-fighting system of the blood, the endocrine gland system, and the image-producing eye) require coding with a high information content. Fifth, the complex behavioural patterns of non-human animals, such as the social systems of bees and ants, and the transcontinental migration of birds, require an adequate level of genetic programming. Finally, there is the complexity of human personality, but this falls outside the scope of our study (Thompson 1981: 118-120).

We have earlier remarked on the ostensible victory of the Darwinian theory over the hypothesis of natural theology, which attributed the complex design found in living organisms to a transcendent intelligence. Since Darwin's principle of natural selection appeared to explain the origins of biological form in terms of simple natural laws, it came to be widely accepted as scientifically superior to previous explanations of organic complexity (Thompson 1981: 135-136). However, recent advances in molecular biology and probability theory have served to undermine the Darwinian theory. As explained by Richard Thompson, 'the origin of complex order can be explained neither by natural selection nor by any other principle based on simple natural laws. Natural structures and patterns of high information content are inherently inexplicable by the reductionistic methods of quantitative analysis. The hypothesis that these structures have been generated by a transcendental intelligent being is therefore in no way inferior... as a theoretical explanation. In addition, this hypothesis opens up the possibility that if the ultimate foundation of reality is a sentient being, then it may be possible to acquire absolute knowledge directly from this transcendental source' (1981: 136). This reasoning by an eminent mathematician evokes the Platonic doctrine that God is the source of both the being and the intelligibility of the cosmos.

10.4 The role of selection

Natural and artificial selection both destroy useless forms, that is to say the unfit. However, Berg adds, evolution also requires selection of the fit, which can only be achieved through artificial selection, 'in which acts the intelligent will of man. The creative side of selection is found in artificial, not in natural selection' (1969: 51). This is illustrated by the difference between the winter and spring varieties of plants such as cereals. In some cases the spring forms are derived from the winter forms, and in others *vice versa*. It was therefore not the artificial selection of *accidental* variations that caused the transformation of winter into spring forms or the other way round; rather, 'Both the spring and the winter forms have existed in Nature from the very beginning. The role of selection is limited to the segregation of pure lines of spring races from mixtures of winter and spring forms, which are observed to occur among wild plants' (Berg 1969: 54).

It should be noted that new forms of domestic animals and cultivated plants can only be produced if a given species possesses the requisite tendencies. These new forms are at any rate all derived from wild forms of which some already had highly diversified characters, such as the dog and the wheat. Therefore, Berg notes, in artificial selection the 'new' is but a revelation of the old (1969: 57). This fact was recognised by Darwin, who wrote that man can only act by selection when variations are first given to him by nature (*Origin*, Chapter 1; 1998: 32). In this context we should note that Darwin's thesis of the evolution of species has been described as based on a confusion between species and simple variation. In the words of Titus Burckhardt, 'Its advocates present as the start or "bud" of a new species what is really but a variant within the framework of a determinate specific type' (1974: 141). That is to say, variation is confused with speciation, as we have remarked earlier.

What is the scope of natural selection? It contributes to the distribution of species (i.e. its action is geographical), Berg contends, and also cuts off deviations from the standard by destroying extreme variations. This phenomenon has led some scientists to conclude that natural selection is actually a principle antagonistic to evolution, since it restricts the development of forms by checking further variations, but never contributes to the production of new forms (Berg 1969: 60-64). This conservative tendency of natural selection is further demonstrated by the phenomenon of mortality. For example, in the cultivation of beans, seeds of medium weight survive best and not the lightest or heaviest seeds; and in a storm killing a number of sparrows, it was observed that the victims differed most from the sparrows of that area in the size of their tails, wings or bills (Berg 1969: 370-1). These observations serve to refute the principle of selection, Berg asserts, since the struggle for survival should favour individuals which deviated most from the standard, with a variation that might by chance be useful. Therefore, 'if a useful character or contrivance is to have any chance of being preserved, it should be simultaneously manifested in a *vast number of individuals*; such individuals would be the most resistant to unfavourable conditions, and the extreme deviations would perish' (Berg 1969: 372).

It appears that the struggle for existence is a conservative agency and not a progressive one, since natural selection serves to maintain the standard and restrict variations (Berg 1969: 400). In a similar vein Pierre Grassé asserted that selection acts more to conserve the inheritance of the species than to transform it (Davison 2000: 9). In other words, natural selection *preserves* the species, instead of *producing* new species. As a matter of fact, Darwin admitted cases where all or most individuals of the same species have been similarly modified without the agency of selection, but he attributed it to a common inheritance producing similar variations (Berg 1969: 372-373). However, Berg counters, if a new form or variety occurs in a single individual or a small number, it will naturally in due course of interbreeding dissolve in the general mass of parental forms. On the other hand, a new form will become dominant only if it becomes so immediately on its arising (Berg 1969: 373-374).

The implication for Darwin's theory is inescapable: 'Since the struggle for existence does not lead to the preservation of single favoured individuals, but, on the contrary, tends to maintain the standard, all theories of evolution based on natural selection fall to the ground' (Berg 1969: 401-402). The theory of natural selection is moreover a veiled acknowledgement of the principle of the inherent fitness of living beings, Berg contends, since it is based on the following principles which are purposive: (i) without variation, no organism could adapt itself to varying external conditions; (ii) without heredity, it would be impossible to fix acquired characteristics; and (iii) the struggle for existence postulates the faculty of self-preservation. The latter is synonymous with fit behaviour, since organisms realise the minimum of variation and the maximum of heredity necessary for self-preservation (Berg 1969: 18-19).

Nonetheless, based on his critical survey of evolutionary theory in the light of biochemical, embryological and palaeontological evidence, David Swift concludes that the notion of natural selection acting on randomly occurring variations does explain a range of biological phenomena. First, by weeding out less fit individuals natural selection maintains the general health of a species (this is its conservative role, as stressed by Berg and others). Second, since the recombination of genes results in a random mixture, natural selection perpetuates the beneficial combinations and rejects the detrimental ones. It is this function that facilitates the adaptation of a species to changing conditions, such as melanism in peppered moths. Third, natural selection at least partly explains the co-adaptation of different species, such as in mimicry and pollination. Finally, in some cases natural selection results in the refinement of characteristics, for example in the cheetah (Swift 2002: 381-382). It therefore appears that Berg's relegation of natural selection to merely affecting the geographical distribution of a species does not do justice to its actual scope.

10.5 The course of evolution

Berg suggests that an organism experiences two kinds of effects in the process of its evolution: inherent in its own organisation and chemical properties, or autonomic (from the Greek *autos*, self); and from its geographical environment, or choronomic (from the Greek *choros*, place). These autonomic and choronomic causes are the two major laws which regulate the development of the organic world and thus determine the outcome of evolution (Berg 1969: 68-69). More recently Richard Lewontin argued along similar lines in his rejection of the reductionist notion that an organism is merely the informational product of its DNA. Instead, the American geneticist wrote, ‘A living organism at any moment in its life is the unique consequence of a developmental history that results from the interaction of and determination by internal and external forces’ (quoted in Van Vrekhem 2012: 198). Yet, that the internal is prior to the external in evolution has also been affirmed by the palaeontologist Otto Schindewolf. He pointed out that the fossil record shows no direct response of organisms to environmental influences; instead, ‘the environment can only provoke and set in motion some potential that is already present’ (quoted in Davison 2006: 2).

The phenomenon of phylogenetic acceleration proves that evolution is to a considerable degree the unfolding of pre-existing rudiments, Berg argues (1969: 402). Phylogenetic acceleration refers to the premature appearance of advanced features in so-called primitive organisms, such as a true placenta in the shark *Mustelus laevis*, the complex ‘organ systems’ within a single cell of the ciliate protozoon *Diplodinium ecaudatum*, and the pneumatic bones in certain flightless reptiles. Features such as the latter are of no adaptive value, thereby suggesting the primacy of internal factors in evolution (Davison 2006: 1-2). It is also noteworthy that *Diplodinium*, which live in vast numbers in the stomachs of cattle, possesses structures similar to a brain, nerve connectives resembling those of annelids and arthropods, muscles, a kind of segmental spinal column, a mouth, esophagus, rectum and anus – all within the confines of a single cell. This confirms, John Davison suggests, ‘that all the necessary information is already present for these structures at the protozoan level’ (2000: 40).

The extinction of organisms is also due to autonomic and choronomic causes, Berg continues, and not to natural selection as held by Darwin (*Origin*, Chapter 4; 1998: 85-86). The Russian biologist explains: ‘Every group of organisms in the course of a definite period attains its optimum, after which, obeying certain impulses concealed in the constitution of the organism, it becomes extinct or is relegated to a secondary position, yielding its place to others.’ For instance, the dominance of gymnosperms and reptiles in the Mesozoic era yielded to that of angiosperms and mammals in the Tertiary period (Berg 1969: 70). As a matter of fact, it is acknowledged in modern biology that extinction is a natural aspect of evolution. This background extinction rate, as it is called, entails a small number of species becoming extinct every year due to natural causes. It is distinguished from mass extinction, of which the present one, at a faster rate than any before, is sadly due to human activity (Cooke *et al* 2008: 26). Berg added that external, geographical causes contribute to the extermination of certain forms only when predetermined by internal factors. The ability of organisms to adapt to their environment reveals the presence of a certain regulating principle. In this way palaeontology concurs with Aristotle’s dictum that nature produces such things, which being impelled by a certain principle confined within them, attain a predetermined end (Berg 1969: 71-72). The biologist John Davison agrees with Aristotle and Berg on the prevalence of auto-regulation in the evolutionary process. Noting that the vast majority of all the organisms that ever existed have become extinct, Davison suggested that they became extinct because they could no longer evolve or otherwise manage to survive (2000: 8-9).

We know from the geological record that there has been at least six mass extinction of life forms over the past 500 million years. The most devastating such event occurred at the end of the Permian period, around 250 million years ago, when over 80% of all species on Earth was wiped out. It appears that the oxygen level dropped from 30% during the Carboniferous period to only 13% by the late Permian. This caused the extinction of most plant and animal life on Earth, including the trilobites. Another notable mass extinction occurred on the boundary between the Cretaceous and Tertiary periods around 65 million years ago, the so-called K-T event. It was probably caused by a gigantic asteroid striking the Earth off the Yucatan coast, which brought about the extinction of the dinosaurs and eventually the rise of mammals from small shrew-like forms to planetary dominance (Alexander 2008: 104-107). However, not all scientists agree with the prevailing view that the dinosaurs were exterminated in a sudden terminal event. According to John Gribbin there is palaeontological evidence in North America that the dinosaurs gradually died out over a period of at least 10 million years (Van Vrekhem 2012: 166-167). Be that as it may, external causes clearly do play a role in the evolutionary process, even if mostly in the form of mass extinctions which in turn lead to vastly increased opportunities for the survivors.

Evidently nature strives both in plants and animals to insure in the best possible manner the preservation and welfare of the developing progeny, Berg noted. That is why the embryo develops in the body of its mother, as found in viviparous mammals and seed plants, i.e. gymnosperms and angiosperms. Evolution thus follows a definite course shaped by both external (geographical) and internal (autonomic) causes (Berg 1969: 113-114). Moreover, 'Evolution bears a sweeping character, and is not due to single, accidentally favourable variations' (Berg 1969: 400). We contend that the latter statement pertains to macro-evolution and not to micro-evolution, which is effected mainly by variation and selection.

10.6 Ontogeny and phylogeny

The embryonic development in vertebrates follows a certain law, Berg points out: first there appears the blastopore or primitive streak, next the central nervous system, next the notochord, next the somites, and then the visceral arches. However, the presence of branchial arches in the human embryo is no proof that humans passed through a fish stage in their phylogenetic development. Instead, it shows that in mammals an organ resembling the branchial arches of lower vertebrates must be formed. According to the biogenetic law of

Oskar Hertwig, there is a repetition of forms obeying the laws of organic development and following a path leading from simple to complex. It could therefore be stated that all ontogeny, i.e. individual development, entails the preparation of future stages by means of preceding ones (Berg 1969: 132-133). Berg's juxtapositioning of ontogeny and phylogeny has been criticised by Ernest MacBride as entailing a broad parallelism and similarity due to 'mysterious evolutionary laws' devoid of deeper meaning. The Anglo-Irish biologist, an exponent of Lamarckian evolution, also expressed his aversion to this display of 'ignorance' by someone 'professing to be a zoologist' (MacBride 1927: 36). However, this personal attack on Berg is accompanied by a singular lack of convincing arguments to the contrary.

More recently the American biologist John Davison argued along similar lines as Berg that just as the information for organic evolution has been predetermined in the evolving genome, so the required information to produce a complete organism is contained within the fertilised egg cell. Therefore, both embryonic development and the evolutionary process involve the ordered de-repression of pre-existing information, so that 'ontogeny and phylogeny become part of the same organic continuum utilizing similar mechanisms for their expression' (2006: 1). This phenomenon is based on the fact that the chromosome and not the gene is the unit of evolutionary change, as had been argued in 1940 by Richard Goldschmidt in *The Material Basis of Evolution* and confirmed in later studies. Thus the primary differences between humans and the higher primates lie in the structural arrangements of their chromosomes, and not their DNA. That is to say, the specific information pertaining to humans, chimpanzees, orang-utans and gorillas was present in a latent state and revealed, or de-repressed, when their chromosome segments were placed in a new configuration. Moreover, these 'position effects' do not entail the acquisition of new information from outside the genome, and it is therefore inconceivable that natural selection could have made any contribution to such chromosome reorganisations (Davison 2006: 4). Therefore, 'all genetic (evolutionary) changes originate in individual cells, in individual chromosomes, in a particular organism' (Davison 2000: 17).

Nonetheless, the recognition that variations arise through the recombination of genes elicits a further problem. As pointed out by David Swift, at present we do not have a satisfactory naturalistic explanation for the origination of genes. In other words, 'the information to produce (potentially) useful variations resides in genes, but we have no adequate explanation for how that information – meaningful nucleotide sequences (and the decoding mechanisms) – arose' (Swift 2002: 399). We contend that genetic information arise due to the activity of the intelligible reason-principles (*logoi*) indwelling all existing things, as Platonism asserts.

It was noted by Berg that new characters, both in ontogenetic and phylogenetic development, arise not at random but in a certain sequence, in which the preceding stage prepares the future one (1969: 134). Recent studies have confirmed that chromosomal reorganisations do not occur randomly as in the Darwinian theory. Instead, it appears that specific regions within the mammalian genome have been predisposed to both micro- and macro-evolutionary rearrangements (Davison 2006: 4). Accordingly, ontogeny not only repeats phylogeny but also anticipates it, as future forms. The adult stages of lower forms thus anticipate the young stages of higher forms; for example, the branchial apparatus of adult fishes is realised in infant amphibians. In summary, 'The laws of the organic world are the same, whether we are dealing with the development of an individual (ontogeny) or that of a palaeontological series (phylogeny). Neither in the one nor in the other is there room for chance' (Berg 1969: 134).

10.7 The orthogenetic formation of characters

It has been observed that flying fishes (genus *Exocoetus*) leap out of water and glide for several hundred meters without any motion of their elongated pectoral fins. A similar elongation of fins is also found in various species of fish that do not leave the water, for example the Aral Sea roach. On the other hand, many other species of fish leap out of the water to migrate or escape predators, but without possessing elongated fins. Evidently, the act of flight played no role in the formation of the fins. From this evidence Berg concludes that elongated pectoral fins have been formed because it was inevitable. That is to say, the particular character was formed due to certain natural laws, without any role played by natural selection or the use/disuse of parts (Berg 1969: 135-140).

Further cases of orthogenetic formation of characters are not difficult to find. In the African egg-eating snake (*Dasypeltis scabra*) the teeth are rudimentary, while the first thirty vertebrae penetrate the wall of the oesophagus and protrude into its cavity. These 'oesophageal teeth' crush swallowed birds' eggs, with their contents passing into the snake's stomach and the shell cast out through mouth. Berg suggests that the anatomical structure of the egg-eating snake was not adapted to a particular function, but the other way round. In other words, the snake feeds instinctively in this unusual manner to utilise the peculiar structure of its anterior vertebrae (Berg 1969: 142). Another notable instance is the reduction of the eye in cave-dwelling and subterranean animals, which could have been affected by the disuse of these organs, although some of their relatives living in the open also possess reduced organs of vision. Again, some blind species live in both caves and the open, while some salamanders (genus *Spelerpes*) have normal eyes but live in caves. It is therefore not living in caves that made them blind, but rather the case that animals with a hereditary tendency to reduced sight can survive better in caves than in the open (Berg 1969: 143).

Turning to the plant kingdom, we find that complex contrivances for fertilisation occur in orchids or for the capture of insects in insectivorous plants. However, among the former some flowers scare rather than attract insects, whereas among the latter some species survive without any insect food, for example in richer soil. These exceptions are clearly incompatible with survival of the fittest, Berg concludes (1969: 144-146). It had earlier been argued by Hugo de Vries that adaptation is not dependent on selection, but that the formation of characters appears to be autonomous. In the words of the Dutch botanist: ‘Specific characters have evolved without any relation to their possible significance in the struggle for life... The usual phrase, that species are adapted to their environment, should therefore be read inversely, stating that most species are now found to live under conditions fit for them... We could say that in the long run species choose their best environment’ (quoted in Berg 1969: 147).

Berg mentions further cases of characters with no apparent use for their possessors. This includes the enlarged teeth of dog salmon and humpback salmon males when they ascend rivers for spawning; the large teeth of the larvae of the eel *Anguilla anguilla* which never eats before metamorphosis; and the crossed tusks of the North American mammoth *Elephas columbi* which were of no use to it, but could rather have led to its extinction. The conclusion to be drawn from this wide range of examples is that characters are formed by internal causes, independently of the degree of utility to the organism (Berg 1969: 148-149).

In view of the foregoing evidence and arguments, Berg concludes that the external features of organisms are the embodiment of accordance with certain laws, and do not arise by chance. It is therefore rather ironic, Berg remarks, that the first chapter of Darwin’s *Origin* is titled ‘Variation under Domestication’, since these minutely differing hereditary forms arise according to law, without any role played by chance. It is recognised that natural selection affects the geographical distribution of some forms, but it can make no contribution to the formation of favoured varieties, since these were already in existence (Berg 1969: 262-263).

10.8 The role of the geographical landscape

The choronomic influences affect an organism in an imperative manner, Berg continues, compelling individuals to vary in a determined manner as far as the organisation of the species permits. The effect hereof is that species that are unable to adapt are obliged to migrate into other geographical landscapes, or to perish (Berg 1969: 265). In other words, when the physical environment alters, organisms are confronted with three possibilities: adaptation, migration, or extinction. As an example of adaptation, one observes that in European fresh-water fishes the number of both species and varieties increase going from north to south, but nonetheless variations in widely separated genera exhibit a tendency to vary in one direction, for instance a decrease in the number of rays in the dorsal and anal fins, as well as changes in coloration and scale sizes. It is highly improbable that similar variations have arisen by chance, Berg remarks. Instead, it appears that several groups of species living in similar conditions are subject to parallel variations, and selection can only operate within these limits. A further example is that in marine fishes of allied genera, a larger number of vertebrates occur in northern than in southern forms (Berg 1969: 265-270).

That choronomic effects are not limited to lower vertebrates is evident from anthropological studies showing that the descendants of European settlers in North America underwent similar variations in bodily characters, for example the shape of the skull, due to the effects of the geographical landscape. These variations, Berg notes, affect all the individuals in the particular immigrant group, thus indicating a certain plasticity of the human organism (1969: 271-273). This organic 'plasticity' was also evoked by Ernest MacBride in his attempt to rebut Berg's insistence on parallel development, which the former explains as the reaction of similar organisms to similar environmental changes (MacBride 1927: 34, 37). However, Berg explicitly affirms the role of choronomic influences in the formation of adaptive characters.

Similarly, various plant and animals species retain their characteristics when moved into a different habitat. Berg suggests that is possible for the effects of landscape to accumulate for some time in order to be manifested in a sudden enhanced variability, while in other cases the reaction occurs rapidly. The same phenomenon is observed in domestic cattle, horses, and sheep in different parts of the world (Berg 1969: 279-281). A remarkable case of rapid adaptation is that of the lunar moth, *Saturnia luna*, which had been transported from Texas to Switzerland, and by the next generation differed so much in form and coloration from the original stock that they were named a new species, *S. bolli* (Berg 1969: 282-3). Further, parallel adaptations are observed in the extremities of mammals, reptiles and insects inhabiting sandy deserts, for improved locomotion in the sand. A similar coloration is also encountered in many species of insects, reptiles and mammals living in the same region.[40] Also in the plant kingdom there are numerous examples of similar development under the influence of similar external conditions (Berg 1969: 287-293). An objection to this reasoning is considered by Berg, namely that organisms established themselves in a particular habitat because they were pre-adapted with suitable features. There are, however, numerous cases of plants directly adapting to a changed environment. Moreover, since all the individuals inhabiting a given landscape vary in a determined direction, there can be no application of the Darwinian principle of infinite variability or the selection of accidentally best-adapted individuals (Berg 1969: 293-294).

The influence of the geographical landscape in the production of new forms has also been recognised by Theodosius Dobzhansky, a leading Neo-Darwinist of the twentieth century. He distinguished between two kinds of evolutionary changes: the first is anagenesis, when a species undergoes adaptive changes in the face of environmental changes but remains a single species; the second is cladogenesis, when a species splits up into two or more species (1967: 123). The latter occurs mostly when members of a species live in different territories with different environments. They first become differentiated into races, which then become genetically more and more different in response to their various environments. Eventually the genetic divergence becomes established, by means of natural selection, as reproductive isolation. In this way the ancestral species is broken up into two or more new ones. Dobzhansky remarks that both anagenesis and cladogenesis occurred in the evolution of most plant and animal groups (1967: 124). However, Dobzhansky’s description of anagenesis could equally well be understood as variation within a species, or micro-evolution.

It appears that geographical isolation is one of the most important agencies in the creation of new forms. Speciation is thus effected through the adaptation of organisms to both their physical and biological environment. This recognition challenges Darwin’s rejection of a ‘law of necessary development’ (*Origin*, Chapter 11; 1998: 265) that causes all the inhabitants of an area to change abruptly or simultaneously or to an equal degree (Berg 1969: 299-300). It appears that the adaptation of organisms to their environment follows a certain (internal)

[40] It was remarked by Alfred Wallace that the variety of striking coloration among birds, insects and flowers is mostly non-utilitarian, serving mainly as recognition-marks among species (Flannery 2011: 116-123).

developmental law.

10.9 The polyphyletic origin of similar forms

Darwin argued in the *Origin of Species* that all animals are descended from a maximum of four or five progenitors, and plants from an equal or lesser number. He added that 'by analogy' it is probable that all organic beings which have ever lived have descended from one primordial form, 'into which life was first breathed' (Chapter 14; 1998: 364). This latter view was confirmed in his *Variation of animals and plants under domestication* published a few years later (Berg 1969: 344). It came to be known as the theory of monophyletic origin, which is emphasised by contemporary Darwinians such as Richard Dawkins. As declared by the English biologist (whose lack of philosophical and theological training does not deter him from regularly making doctrinaire pronouncements in these areas of knowledge), 'We can be very sure there really is a single concestor [common ancestor] of all surviving life forms on this planet... The evidence is that all that have ever been examined share... the same genetic code... As things stand, it appears that all known life forms can be traced to a single ancestor which lived more than 3 billion years ago' (Dawkins 2004: 12-13).

The monophyletic descent postulated by Darwin was supported from a different angle by Karl Schneider, who argued that every simple form contains potentially a more complex form, with the latter evolving from the former. According to Schneider, 'there must exist some one primordial form, within which all the remaining forms are "enfolded" (*eingewickelt*), all the morphological potentialities having already been contained in the primordial cell (*Urzelle*)' (quoted in Berg 1969: 358). Ironically, while supporting monophyletism, the German zoologist evoked precisely the classical conception of evolution as the unfolding of inherent possibilities. This notion was also supported by the geneticist William Bateson, who viewed the entire evolutionary process as 'the unpacking of an original complex which contained within itself the whole range of diversity which living things present' (Berg 1969: 359).

Opposing the theory of monophyletic descent, Berg argues that due to the vast number and variety of life-forms the number of primal ancestors must be thousands or tens of thousands (1969: 358). The theory of polyphyletic origin is based on a wide range of palaeontological evidence. For instance, in the case of the dinosaur groups Saurischia and Ornithischia, the latter is not derived from the former as was earlier assumed, but instead they were parallel branches. In the phylum Arthropoda, the crustaceans and arachnids owe their origin to mesomeric worms, while the myriapods and insects owe their origin to polymeric worms. And in the plant kingdom the angiosperms and gymnosperms developed independently from different ancestors (Berg 1969: 338-339).

It was further argued by Berg that organs such as the notochord, gill-slit, and dorsal nervous system developed independently in various groups of animals, and not only in the ancestors of fishes (1969: 341). Berg's postulation of independent evolution of the notochord in amphioxus and in higher vertebrates has been dismissed as a 'crude and unjustifiable guess' by Ernest MacBride (1927: 34), on the grounds that it would not be accepted by any British authority. This non-argument does not deserve our further consideration. Further examples from palaeontology of parallel, independent development of characters mentioned by Berg include molluscs, ammonites, and flightless birds. The principle of polyphyletic origin leads to the conclusion that 'points of resemblance in two forms may represent something secondary, acquired and new, whereas points of dissimilarity are something primary, inherited and ancient' (1969: 345-347). This is the antithesis of Darwin's law of divergence, which is not denied by Berg, but the law of convergence operates next to it and even dominates it.

A further argument in favour of polyphyletic origin is provided by the phenomenon of polytopical formation. This refers to the arising of identical forms in various places within the limits of one species, which are hereditary as long as the conditions remain invariable. It is evident, for example, in a number of marine salmon and trout species across the northern hemisphere, of which some individuals remain permanently in fresh water where they give rise to dwarf forms. The independent origin of the same form in different places has also been observed in plants and invertebrates (Berg 1969: 351, 352-356).

The French geologist Paul Lemoine pointed out that the geological record indicates the sudden appearance of all new groups, whereas changes in existing animals take place (as a rule) slowly. Based on the evolutionary rates of insects, for example, he argued that in order to believe in the monophyletic origin of life one has to invoke astronomical periods, dating back to times when the Earth or even the solar system had not yet come into existence (Dewar 2005: 261). The principle of polyphyletic origin is moreover consonant with the absence of transitional forms between separate groups, since there is no common root. Berg concludes, 'Both convergence and the absence of transitions support the view that evolution advances by means of the transformation of vast numbers of individuals into new forms' (1969: 361). The phenomenon of convergent evolution will be considered in a later chapter.

10.10 The formation of new species

Regarding the formation of new species (i.e. speciation), Berg argues that the production of new forms occurs in the context of geographical isolation (Berg 1969: 363). Opposing Darwin's view that only individual variations contribute to the production of new species, with natural selection acting on only a few inhabitants of the same region, Berg writes: 'In the origination of new geographical forms … a vast number of individuals inhabiting a certain geographical area are simultaneously involved in the production of new characters. There can be no question of an accidental occurrence of characters. Thus, in the production of geographical forms natural selection plays no part' (1969: 364). It appears further that geographical forms are attributable to external agencies such as landscape, whereas non-geographical forms are due to internal causes (Berg 1969: 365-367). In the formation of species, Berg continues, there is 'the simultaneous *en masse* manifestation of new characters over a vast territory' (1969: 368). This refutes the opinion of Darwin that natural selection acts very slowly and on only a few of the inhabitants of the same region at the same time (*Origin*, Chapter 4; 1998: 84). However, in his later work *Variation of Animals and Plants* the English naturalist recognised that new sub-species could be produced through external conditions without the aid of selection (Berg 1969: 369).

An interesting analogy is mentioned by Berg, namely that the mass appearance of similar variations is analogous to new formations in languages, which arise simultaneously in large groups of individuals, while single variations disappear with the death of the individuals using them. Moreover, linguistic changes occur simultaneously over large territories, of which examples are found in Russian, Spanish, French and Classical Greek (Berg 1969: 374-376). According to studies by the French linguist Antoine Meillet, innovations occur among all children born in the same locality, differing from the speech of the adults. Such variations are transmitted to younger generations, thereby modifying the language in time. As in the case of animals and plants, Berg contends, so also in languages new formations rapidly succeed each other in some complexes (species, languages), while in others characters are more stable. We thus encounter an analogy between languages and species giving rise to new forms in time and in space (Berg 1969: 375-377).

In contemporary biological terms, speciation occurs either through allopatric or sympatric mechanisms, which refer to geographical and reproductive isolation, respectively (Alexander 2008: 94). Among plants sympatric speciation is more common, whereas allopatric speciation occurs more often among animals. The latter process results when a breeding population is split in two, for example through continental drift. Both mechanisms have been observed to facilitate rapid speciation, as admitted by Denis Alexander even though he works within a Neo-Darwinian framework. In the plant kingdom this takes place by means of chromosomal doubling, which is also known as polyploidy. A prominent example thereof is the salsify genus *Tragopogon*, in which several new species have been formed in North America by means of chromosomal doubling within a few decades (Alexander 2008: 94-95). This is therefore an instance of micro-evolution resulting from genetic reshuffling.

In the animal kingdom rapid speciation is demonstrated by the case of the cichlid fishes in the Great Lakes of Africa, in which during the past million years more than a thousand new species have appeared. More than 170 cichlid species are still living in Lake Victoria, filling a wide range of ecological niches and with the morphology of each species adapted to their feeding habits. In the nearby and much smaller Lake Nagubago, which became separated from Lake Victoria around 4 000 years ago, at least five endemic cichlid species have evolved since then. The remarkable case of the African cichlids shows that relatively rapid specation can be stimulated by a suitable environment (Alexander 2008: 98-99). The Lake Nagubago case was also commented on by Ernst Mayr, who contrasted it with that of the Panama Isthmus which has separated the Pacific and the Caribbean for approximately 5 million years, and yet the marine fauna with their massive gene pools on either side are virtually identical. These anomalous rates of evolution present a challenge to the Darwinian model, in terms of which a larger population will have an increased chance of favourable mutations, and will hence display more variability and a more rapid rate of evolution (Swift 2002: 247-248).

10.11 The limits between species

The notion of species has been borrowed by naturalists from philosophy. It was introduced by Aristotle, who viewed a species as an irreducible peculiarity which makes the thing what is (Berg 1969: 389-390). As we noted in an earlier chapter, the essence of a living being is related by Aristotle to reproduction, so that a species is characterised by the ability to produce fertile offspring, as contrasted with the reproductive sterility observed in hybrids (O'Rourke 2004: 25). That is to say, a species is reproductively isolated (Alexander 2008: 93). For Aristotle, moreover, the reproductive ability of a species is metaphysically based: 'Since it is impossible for it [i.e. a living thing] to be eternal as an individual..., it is possible for it to be eternal in species. This is the reason why there exists eternally the class of human beings, animals, and plants' (*Generation of Animals* 731b-732a; quoted in Gerson 2005: 118). The Aristotelian view was evoked by Buffon, who saw a species as a continuous succession of similar and multiplying beings. And according to Kant, the species in nature are actually isolated from one another and thus form a *quantum discretum* (Berg 1969: 390).

The reality of species has been related by Titus Burckhardt to the classical notion of hylomorphism, in terms of which every individual thing is a conjunction of a specific matter with a specific form. While the form of a thing is the seal of its essential unity, its matter is 'the plastic substance that receives this seal while conferring on it a concrete and limited existence.' Therefore, Burckhardt argues, 'it is only in connection with a "matter", or plastic substance, that "form" plays the part of a principle of individuation; in itself, in its ontological basis, it is not an individual reality but an archetype, and as such it lies beyond limitations and beyond change. Thus a species is an archetype, and if it is only manifested by the individuals belonging to it, it is nonetheless as real and indeed incomparably more real than they are.' Moreover, since a species is an immutable 'form', it could not evolve and become transformed into another species. It can, however, produce variations as 'projections' of a single essential form, like the branches of a tree (Burckhardt 1974: 140-141).

This metaphysical affirmation of the reality of species was opposed by Darwin, arguing that the term species is arbitrarily given for the sake of convenience. He added that a well-marked variety may justly be called an incipient species. That is to say, the term 'species' does not differ essentially from the term 'variety', which is likewise applied arbitrarily for the sake of convenience (*Origin*, Chapter 2; 1998: 42). This argument reminds one of the Medieval debate between nominalists ('things having the same name share nothing more than the name') and realists ('things exist in reality, independently of our concepts and language'). It is our contention that the Darwinian rejection of the reality of species is linked to its insistence on gradualism: if minute variations indeed accrue incrementally over numerous generations to form new species, then there could *ipso facto* be no real boundaries between species.

The militant Darwinist Richard Dawkins went so far as to attribute the notion of species to 'the tyranny of the discontinuous mind', which entails an 'obsession with discrete names' (2004: 252). After thus displaying his nominalist proclivity, Dawkins admits that the majority of living animals are in fact discontinuous from one another, for example humans and chimpanzees. The English biologist attempts to explain this fact by suggesting that the intermediates between surviving species are mostly extinct, so that ‘evolution tells us there are other lines of gradual continuity linking literally every species to every other’ (Dawkins 2004: 258-259). Following the example of Ernst Mayr, the ‘delusion of discontinuity’ is laid at the door of Plato’s philosophy of ‘essentialism’, while in reality species do not change into other species but are said to have evolved from a common ancestor. Echoing Darwin, it is then suggested that we continue using names for apparently discontinuous species, while keeping in mind that they are no more than a ‘convenient fiction’ (Dawkins 2004: 259, 261).

Against these nominalist arguments by Darwin and Dawkins, it is stated by Berg that the notion of species is empirically confirmed. When a group of individuals resembling each other more than members of any other group is compared with another such group, and the differences between the two groups are sufficiently perceptible, we are dealing with a species. That is to say, species are those complexes of forms which are morphologically distinguished and also genetically different from neighbouring form-complexes (Berg 1969: 390-392). Since mutation always involves leaps, Berg adds, species are clearly distinguished from one another. For their part, sub-species are always connected with species by means of transitions, but may in the course of time be disconnected from them in two ways: when a sub-species evolves into a new form, or when transitional forms become extinct (Berg 1969: 395).

However, in practice the definition of a species is not always a clear-cut matter. On the one hand there are cases which are morphologically highly different, but they readily interbreed. On the other hand there are cases which are morphologically highly similar, but they are unable to interbreed. The latter are called ‘sibling species’, first discovered in the fruit fly *Drosophila*. From this phenomenon David Swift concludes that there are genetic isolating mechanisms which are unrelated to morphological differences (2002: 112-113).

10.12 Mutational theory

The German palaeontologist Wilhelm Waagen was the first to establish the notion of mutations in an 1869 publication, as underlying the transformation of species. These mutations, Berg contends, arise due to a law inherent in the organism, in other words due to autonomic causes. In contrast, geographical varieties are due to external effects, or choronomic causes (Berg 1969: 384-385). Since the mutational production of forms proceeds by saltation, the fossil record shows periods when nature displays a kaleidoscope of organic forms, and others when nature works at a slower rate. The major geological divisions thus correspond to sharp alterations in fauna and flora. Furthermore, this mutational theory explains the phenomena of polyphyletic origins, the sudden appearance of species, and the absence of transitions between species. It could therefore be stated that species arise either through mutational transformation *en masse*, or through geographical isolation (Berg 1969: 386-387). These two alternatives correspond to the distinction we are making between macro-evolution and micro-evolution.

According to the mutational theory of the Dutch botanist Hugo de Vries, new forms are produced in sudden leaps. For example, the single leaved strawberry *Fragaria monophylla* was obtained suddenly from seeds of the common European strawberry *F. vesca*, and proved to be constant. However, mutations are generally displayed in a very small number of individuals, so that in wild plants they usually become extinct, and in cultivation they often do not blossom or produce seeds (Berg 1969: 377-378). The experiments by De Vries and others show that new forms cannot arise due to individual variations, whether hereditary or non-hereditary. For the production of new forms a transformation *en masse* of the entire or the major part of the individuals living in a definite territory is required, and only in this manner can variation be fixed by heredity. Such a transformation of forms *en masse* occurs due to either choronomic or autonomic causes (Berg 1969: 383-384). Berg's theory of speciation through sudden mass mutation was criticised by Ernest MacBride as ignoring well-known fossil series such as those of the horse and the camel on the one hand, and the imperfection of the fossil record on the other hand (MacBride 1927: 37). We have already considered the latter objection and found it wanting, while the mentioned fossil series could be viewed as cases of micro-evolution for which gene reshuffling and selection have been sufficient.

Against Leibniz's dictum that *natura non facit saltus* (Latin, 'nature does not jump'), Berg points out that in both the physical and the ideal worlds (i.e. the sensible and intelligible realms of Hellenic metaphysics), rhythm is a manifestation of the law of intermittent development. Accordingly, 'The birth or death of individuals, species, ideas is a catastrophic process. The manifestation of every class of these phenomena is preceded by a long latent period of development, which follows certain definite laws, and then suddenly culminates in a bound, *saltus*, by which the group emerges into the light, is distributed over the earth's surface, and wins for itself "a place in the sun". The same gradual internal process precedes death, which takes place suddenly' (Berg 1969: 387-388). This phenomenon that 'nature does jump' (*natura facit saltus*) is paralleled in quantum physics and differential calculus. Moreover, palaeontology confirms the rapid production of new forms. Thus in the Permian period the Stegocephala flourishes, in the Triassic the reptiles, in the Lower Cretaceous the angiosperms, on the border between the Lower and Upper Cretaceous teleostean fishes dominate, and in the Lower Tertiary the mammals (Berg 1969: 388-389). This evidence also rebuts the assertion by Darwin that there are no sudden leaps in nature, since natural selection works slowly on slight successive variations (*Origin*, Chapter 14; 1998: 355).

Berg's stance on the sudden appearance of new species was supported by the geneticist Richard Goldschmidt and the palaeontologist Otto Schindewolf. Goldschmidt pointed out that micro-evolutionary adaptations to the environment do not exceed the boundaries of species. In contrast, species and the higher categories originate in single macro-evolutionary steps as completely new genetic systems. These are produced by means of a comprehensive transformation of intra-chromosomal structures, so that 'A single modification of an embryonic character produced in this way would then regulate a whole series of related ontogenetic processes, leading to a completely new developmental type' (quoted in Davison 2000: 29-30). And according to Schindewolf, macro-evolution takes place in an 'explosive' way within a short geological time, followed by a slower series of orthogenetic perfections (i.e. micro-evolution). Schindewolf employs examples from the fossil record to show that the major evolutionary advances must have taken place in single large steps, 'which affected early embryonic stages with the automatic consequence of reconstruction of all the later phases of development' (quoted in Davison 2000: 30).

10.13 The laws of evolution

Employing Max Planck's distinction between statistical and dynamic laws, Berg reasons that if evolution had taken place in accordance with tychogenesis, its laws would have been similar to those physical laws which are of a statistical character. These are irreversible processes such as the conductivity of heat and electricity, diffusion, friction, and chemical reactions – all of which are governed by the second law of thermodynamics. In contrast, the laws of nomogenesis are of a dynamic character, namely reversible processes such as gravitation, electric and mechanical oscillations, acoustic and electro-magnetic waves (Berg 1969: 405). This distinction implies, fascinatingly, that Darwinian evolution, entailing tychogenesis, is more static in nature than evolution according to natural law, or nomogenesis.

The following natural laws are recognised by Berg (1969: 154-155, 234):
(i) Higher characters or their rudiments appear in lower groups very much earlier than they are manifested in full development in organisms occupying a higher position in the system – evolution is therefore mostly (but not only) the unfolding of pre-existing rudiments;
(ii) The successive manifestations of new characters are governed by law. In the process of evolution there is no place for chance: new characters appears where they should appear – both ontogeny and evolution are thus prescribed by law;
(iii) Therefore evolution follows a determined direction – instead of chaotic variation;
(iv) Some characters owe their development to internal (autonomic) causes inherent in the very nature of the organism, and independent of any effects of the environment – this is particularly evident in the ontogenetic process;
(v) The laws of development of the organic world are the same both in ontogeny and phylogeny – thereby affirming the 'recapitulation' of phylogeny by ontogeny;
(vi) Both in phylogeny and in ontogeny characters develop at a different rate: some repeat, as it were, the former stages, others predetermine the future ones; and
(vii) Every organism consists of a combination of characters which evolve to a considerable degree independently one of another.

In summary, for Berg evolution is (mainly) autonomic and not ruled by chance. The formation of new characters occurs due to the effects of the geographical landscape, so that they are choronomic in origin. Both ontogenetic and phylogenetic development follow certain laws common to both, thus confirming the reality of nomogenesis. This accordance with autonomic laws is best shown in the life-forms that developed convergently (Berg 1969: 402-404). However, during the course of the twentieth century the theory of recapitulation (i.e. that ontogeny recapitulates phylogeny) was demonstrated as erroneous, notably by Gavin de Beer in a number of his works. According to the English embryologist there is no evidence of higher organisms evolving by additional developmental stages from lower organisms. For example, the early appearance of 'gill-slits' in the embryos of fish, reptiles, birds and mammals are actually visceral pouches. Whereas in the case of fish these pouches are elaborated into gills, among reptiles, birds and mammals they are transformed into the Eustachian tube, tonsils, thymus glands and other structures. De Beer admitted a degree of similarity between the embryos of fish, reptiles, birds and mammals, but emphasised that in the later stages their respective ontogeny diverged (Swift 2002: 335-336). It therefore appears that Berg erred in his affirmation of the recapitulation of phylogeny by ontogeny.

10.14 Darwinism versus nomogenesis

In the final pages of his monumental work, Berg juxtaposes the salient features of Darwinism and nomogenesis (1969: 406-407). The Darwinian theory of evolution is characterised by the following: (i) All organisms have developed from one or a few primary forms, i.e. in a mono- or oligo-phyletic manner. (ii) Subsequent evolution was divergent, (iii) based on chance variations, (iv) to which single and solitary individuals are subject, (v) by means of slow, scarcely perceptible, continuous variations. (vi) Hereditary variations are numerous, and they develop in all directions. (vii) The struggle for existence and natural selection are progressive agencies. (viii) Species arising through divergence are connected by transitions. (ix) Evolution implies the formation of new characters. (x) The extinction of organisms is due to external causes, the struggle for existence and the survival of the fittest.

In contrast, nomogenesis entails the following features: (i) Organisms have developed from tens of thousands of primary forms, i.e. polyphyletically. (ii) Subsequent evolution was chiefly convergent (and partly divergent), (iii) based upon laws, (iv) affecting a vast number of individuals throughout an extensive territory, (v) by leaps, paroxysms, or mutations. (vi) Hereditary variations are restricted in number, and they develop in a determined direction. (vii) The struggle for existence and natural selection are not progressive agencies, but being, on the contrary, conservative, maintain the standard. (viii) Species arising through mutations are sharply distinguished one from another. (ix) Evolution is in a great measure an unfolding of pre-existing rudiments. (x) The extinction of organisms is due to a combination of inner (autonomic) and external (choronomic) causes.

10.15 Palaeontological confirmation of mass mutations

Berg’s postulation of simultaneous mass mutations as the primary means in the production of new species is strikingly confirmed by the so-called Cambrian Explosion. This event has been aptly labelled the Big Bang of animal evolution (Alexander 2008: 124). It refers to the sudden appearance in the fossil record of around 90 percent of the animal phyla living today, during the Cambrian period (around 542-488 million MYA). In the vast pre-Cambrian era the earliest microfossils date back to around 3.5 billion years ago, during the Archaean. For the next three billion years prior to the Cambrian, life on Earth was confined to single-cellular and tiny multi-cellular forms, less than 1 mm in diameter and dominated by algae. And then, within a few million years beginning around 525 MYA, the ancestors of today's sponges, jellyfishes, corals, brachiopods, crustaceans, annelids, gastropods, cephalopods, sea lilies and jawless fishes all appear on the scene, or rather in the rocks. This includes complex animals with limbs, antennae, eyes and tails. The Cambrian explosion also witnessed the first appearance of animals with hard shells and exoskeletons, probably spurred by an increase in predatory species. The jawless fishes known as Agnathans appearing towards the close of the Cambrian, around 480 MYA, were the first vertebrates (Cooke *et al* 2008: 24, 27-28; Alexander 2008: 88-90, 124). Compounding the transformist dilemma is the fact that these jawless fishes appear in large diversity as fully differentiated forms, with no evidence of intermediates linking them (Swift 2002: 264).

Already by the middle of the twentieth century more than 1 100 genera of Cambrian animal fossils had been described, found in numerous localities in both hemispheres. All of these forms are said to have developed out of mostly single-celled ancestors. However, if the Darwinian hypothesis of slow, gradual speciation was correct, then the rocks of the pre-Cambrian periods should have yielded a plethora of transitional forms for this huge diversity of marine fauna. However, such evidence is lacking, despite efforts to present pre-Cambrian fossils other than algae. For example, the supposed fossil of a giant foraminifer named Eozoon was shown by further investigation to have been non-organic in its structure (Dewar 2005: 19-20, 25). An exception is the Ediacaran fossils discovered first in South Australia and then on other continents. These fossils, dated to around 565 million years ago, consist of soft-bodied marine fauna such as jellyfishes and worms, as well as forms unlike those of any other period. However, they became extinct in the early Cambrian and therefore played no further part in the evolutionary process (Cooke *et al* 2008: 27; Alexander 2008: 122). In addition, recent discoveries have narrowed the gap between the Cambrian and Ediacaran fossils from as much as 100 million years to 13 million years (Swift 2002: 260).

Various explanations have been offered to account for the relative lack of pre-Cambrian fossils, presenting as it does a serious challenge to Darwinian gradualism. For instance, it has been suggested that all the pre-Cambrian rocks have been altered to the extent that the fossils they originally contained have all been destroyed. However, Douglas Dewar pointed out, unaltered sedimentary rocks predating the Cambrian exist in many parts of the world, in layers several kilometres in thickness. Some of them are so perfectly preserved that fossilised water marks can be seen, but no evidence of organic fossils. Another transformist argument is that all the pre-Cambrian marine animals either lacked shells or had fragile shells that could not be fossilised. Again, this does not explain the existence of molluscs and brachiopods in the Lower Cambrian possessing thick shells, or the fact that soft-bodied animals such as jellyfish have left perfect impressions in sedimentary rocks (Dewar 2005: 27-28). Moreover, even if it is granted that the soft-bodied predecessors of the Cambrian fauna were unable to leave any traces, so that the sudden appearance of one evolving line in the fossil record is not surprising, it still does not explain the sudden appearance of such a wide variety of forms with hard parts at the same time. Equally remarkable is the radically different skeletons of the trilobites, sponges, echinoderms, molluscs, and the first vertebrates appearing in the Cambrian. These skeletons are produced by intricate biological processes, which makes their simultaneous appearance even more difficult to explain in Neo-Darwinian terms (Swift 2002: 260-262).

Remarkably, plant life remained confined to mostly algae for another 100 million years or so after the Cambrian period, until the Devonian (around 416-359 MYA). In the rocks of the latter period an abundance of plants (at least ten classes) make their appearance, including fungi, club-mosses, ferns, horse-tails, and Gymnosperms such as conifers (Cooke *et al* 2008: 24; Dewar 2005: 40). These ‘higher’ plants had complete vascular systems for the transport of water and nutrients, and again we encounter such highly differentiated structures appearing within a relatively brief period in the distinct sub-phyla of ferns, horse-tails and club-mosses. With these vascular plants the first leaves also appear, in two differentiated types: the ‘simple’ leaf and the frond-like leaf as found in ferns, with no intermediates linking them or any known predecessors (Swift 2002: 277-278).

Also making their first appearance in the Devonian is the class of Insecta. With around a million described species in 29 orders, insects comprise more than half of all known animal species, and it is estimated that several more million insect species are awaiting discovery. Inhabiting all of the Earth’s habitats in prodigious numbers, insects are by various measures the most successful animals to have lived on Earth (Cooke *et al* 2008: 552). The earliest fossil insects were wingless springtails and bristletails, both appearing fully developed with the tri-segmented body of modern insects. They were followed much later, in the late Carboniferous, by winged insects, which also appear fully specialised, and with no known intermediates linking them with wingless insects. Among winged insects both those with folded wings and rigid wings appear in the fossil record with no intermediates linking them to each other or to any predecessor. David Swift concludes: ‘Although the insects are the most diverse animal group, and have been abundant at least since the Carboniferous period, we cannot trace an evolutionary origin of insects as a whole or of their principal groups' (2002: 276-277).

Nor are these Cambrian and Devonian 'explosions' the only instances of a sudden outburst of new life-forms found in the geological record. The following examples from various periods following the Cambrian are presented by Douglas Dewar (2005: 36-37, 40-42, 45-49, 55-58):
(i) Ordovician (488-444 MYA) – two orders of jawless fishes, two classes of Echinoderms, 14 families of Crinoidae and 19 families of Bryozoa; also fossilised plant spores, dated 475 MYA (Alexander 2008: 125), and the first appearance of cartilaginous fishes, such as sharks (Cooke *et al* 2008: 28);
(ii) Silurian (444-416 MYA) – a sub-class of fish with jaws (Selachians), a class of Echinoderms, two orders of Echinoidae and two genera of scorpions; these arthropods were the first animals on land, their hard exoskeleton restricting water loss (Cooke *et al* 2008: 28); also the first plants without leaves, with fossils dated 430 MYA (Alexander 2008: 125);
(iii) Devonian (416-359 MYA) – various bony fish groups, and the first appearance of millipedes, crustaceans, molluscs, and amphibians; due to the proliferation of fishes this period is often referred to as the Age of Fishes (Cooke *et al* 2008: 28);
(iv) Carboniferous (359-299 MYA) – 12 orders of arachnids (including the first appearance of spiders), 12 orders of insects (of which most have become extinct), 14 families of amphibians, and the first appearance of reptiles; spiders thus appear simultaneously with much of their prey (insects) and with their weaving apparatus already developed (Burckhardt 1974: 146);
(v) Permian (299-251 MYA) – 5 orders of reptiles, including turtles and tortoises; the latter appearing suddenly with its mollusc-like external skeleton (Burckhardt 1974: 146);
(vi) Triassic (251-200 MYA) – the order of Dinosaurs, first appearing as 6 families of Theropoda spread around the world and thus discounting a monophyletic origin, as well as the mollusc group of cuttle-fish and squids;
(vii) Jurassic (200-145 MYA) – two orders of amphibians, the Urodela (including newts) and the Anouria (including frogs); the Pterodactyls (winged reptiles); the Mesosauria (aquatic reptiles); and the first appearance of birds, namely *Archaeopteryx* and *Archaeornis*;
(viii) Cretaceous (145-65 MYA) – 16 families of bony fishes (Teleostei); 3 orders of teethed birds; the first appearance of placental mammals, in an order of Insectivora; and an abundance of Angiosperms, or flowering plants, dating from around 125 MYA (Alexander 2008: 125);
(ix) Eocene (56-34 MYA) – 27 families of bony fishes; a large number of mammalian forms, including carnivores, odd- and even-toed ungulates, hyraxes, edentates, rodents, cetaceans,

sea-cows, bats, primates, pangolins and aardvarks, as well as 11 orders that have become extinct; and 9 genera of birds without teeth.

The fossil record indicates that the Angiosperms, or flowering plants, appear within a few million years during the middle Cretaceous, in the form of around 50 families containing hundreds of species. However, that the picture may be rather more complicated is suggested by the discovery of Angiosperm pollen in pre-Cambrian rocks in South America, dated to between 1.7 and 2 billion years ago (Thompson 1981: 187, 191). Be that as it may, although Angiosperms comprise around 80% of living plant species (including flowering trees), their evolutionary origin is shrouded in mystery. For instance, there are fundamental differences in the structure of both the reproductive organs and the leaves between the Angiosperms and the Gymnosperms supposedly preceding them, but there is no palaeontological evidence showing any intermediates. Moreover, the two main groups of flowering plants, the monocotyledons and dicotyledons (i.e. with one or two seed leaves, respectively), appear independently and with no known intermediates linking them (Swift 2002: 279-280).

It was argued by Douglas Dewar that if the Darwinian hypothesis of gradual transformation was correct, the following features should be confirmed by the fossil record: (a) every class, order, family and genus would appear as a single species, exhibiting no diversity until it had been in existence for a long time; (b) the flora and fauna of any given geological period would differ but slightly from those immediately above and below, except on the rare occasions of sudden climate change, e.g. due to inundation by the sea; (c) it should be possible to arrange fossils in various chronological series showing the origin of the animal and plant classes as well as smaller groups, thereby enabling us to accurately trace the descent of most of the species now living to the Cambrian fossils; and (d) the earliest fossils of each new group would be difficult to distinguish from those of the group from which it evolved, and the distinguishing features of the new group would be poorly developed (Dewar 2005: 35).

However, the palaeontological evidence does not confirm any of these features. First, new classes and orders often appear in the fossil record in great variety (as mentioned above) and not in the form of a single species (Dewar 2005: 58). Second, although there are many cases where the fauna and flora in a particular period differ little from those above and below, numerous exceptions also occur. For example, of the 3 amphibian and 9 reptilian orders living in the Permian, none survived until the Jurassic, whereas 2 and 8 new orders, respectively, had arisen by then; and of the 4 mammalian orders living in the Jurassic, none survived until the Eocene, while 20 new mammalian orders appeared in the latter period (Dewar 2005: 59). Third, there is no genealogical series of fossils proving beyond doubt that any species in the past has transformed itself into a member of a different family. And finally, the earliest known fossils of each class and order appear in the fossil record as fully developed forms, with subsequent changes being relatively insignificant. Examples thereof are the pterodactyls, turtles, icthyosaurs, bats, cetaceans, sirenians and seals (Dewar 2005: 58, 61). To this list one could add the significant fact that the basic body plan of vertebrates appears suddenly in the fossil record, without any recognisable predecessors (Thompson 1981: 187).

Even such a staunch Neo-Darwinist as George Simpson noted that most new species, genera and families, and nearly all the taxa above the level of families, appear suddenly in the fossil record and without continuous transitional sequences (Smith 2008: 70). Simpson mentions, for example, that all 32 orders of mammals appear fully developed in the fossil record. He also admitted that the absence of transitional forms is a global palaeontological phenomenon (Thompson 1984: 50). In his more recent work David Swift noted that the fossil record displays the following patterns: the abrupt appearance of distinct groups, diversification (including anomalous rates of evolution), and stasis. The latter term indicates species appearing and disappearing without evolving into one another. However, a recognition of morphological stasis does not preclude temporal and spatial variation. Biochemically speaking, the sudden appearance of new groups corresponds with the abrupt, i.e. non-gradual, appearance of new genetic material. That is to say, the essential protein structures were already determined by the time these groups appear on the scene (Swift 2002: 280, 287, 383).

Contrary to the popular view that the fossil record provides convincing evidence for evolution in the Darwinian sense of the word, it does not account for the appearance of a single phylum from a preceding one, since they all appear abruptly. This phenomenon also pertains to lower taxa such as classes and orders, while evidence of an ancestral line is found only on the levels of genera and species. However, these (micro-evolutionary) changes can be accounted for in terms of gene segregation, and not the acquisition of new genes. It is therefore concluded by Swift that ‘although we find evidence of evolution in terms of gene shuffling, yet again we find no explanation for the origin of genetic material. The fossil record offers no evidence at all that the fundamental problem of the improbability of biological macromolecules has been overcome’ (2002: 295). In other words, both palaeontology and genetics provide evidence against the possibility that macro-evolution can occur by means of Darwinian mechanisms.

10.16 Biochemical confirmation of lawful evolution

During the late twentieth century the science of biochemistry began to provide affirmation for the Platonic cosmogony in the organic realm. Most biologists now accept that at least some biological forms arose spontaneously out of the self-organising properties of their constituents, Michael Denton notes, without genetic programming. Examples thereof include the spherical form of the cell and the flat form of the cell membrane. Furthermore, the 'origin of life' is the only area of modern biology with a strongly deterministic element, to the extent that many researchers view life's origin as the inevitable end of planetary evolution (Denton 2002: 329-330). A leading contemporary proponent of this view is Simon Conway Morris, whose work will be considered in a later chapter.

Regarding the phenomenon of protein folds, the pre-Darwinian notion of organic forms provides a more powerful explanatory framework than its selectionist successor, Denton contends (2002: 330). Protein folds are the basic building blocks of proteins, and thus of cells and all life on Earth. Each fold is a polymer consisting of 1000 to 3000 atoms folded up into a complex three-dimensional shape. In the 1970's it was discovered that protein folds might be limited in number, at the same time as the number of three-dimensional protein structures grew significantly. The folds are therefore classified into a finite number of distinct structural families containing related but variant forms. This implies that protein folds might be natural forms determined by physical law, rather than artifactual constructs assembled by natural selection. It also became apparent that these three-dimensional structures were essentially invariant – for example, the Globin fold and the Rossman fold has remained essentially unchanged for billions of years. Therefore, both the facts of typology and invariance imply that protein folds are a finite set of timeless structures determined by physics, instead of mutable aggregates of amino acids determined by selection (Denton 2002: 330-331).

The fold structures display a rational and generative morphology, Denton continues, with rules governing the way in which α helixes and β sheets can be combined into compact three-dimensional structures. Moreover, there are physical constraints restricting the folded spatial arrangements of the linear polymers of amino acids, thereby suggesting a relatively small number of permissible folds. The total number of theoretically possible protein structures formed by an amino acid chain of 150 residues long is 3^{150} or 10^{68}, while in reality the total number of stable three-dimensional structures allowed by physics is limited to around 1000 unique conformations. Therefore, Denton concludes, the folds represent a finite set of allowable physical structures that would recur throughout the cosmos wherever carbon-based life occurs, using the same twenty amino acids as on Earth (2002: 331-332). It was admitted in this regard by the geneticist Richard Lewontin that the amino acid sequences (as coded by the genes) are insufficient to explain the folding of proteins into complex three-dimensional structures. Also, while there are many alternative folded states for each sequence, only one is the physiologically active protein (Van Vrekhem 2012: 197).

There are also many cases where protein functions are clearly secondary adaptations of a primary, immutable form. It thus appears that the basic protein fold has been secondarily modified for various biochemical functions. For instance, the globin fold in myoglobin and various vertebrate hemoglobins entails various functional adaptations to the absorption and conveyance of oxygen. Denton contends that even the extreme Platonic view of Goethe, that form directly determines function, may be valid in cases where a particular protein function arises from the association of a particular fold with a particular prosthetic group, co-factor or metal ion (2002: 332).

The phenomenon of protein folds furthermore has a linguistic analogy, because the meaning of a word in a sentence depends on its context. Similarly, proteins are holistic entities, since the current evidence suggests that the various parts of the fold exert a mutual and reciprocal formative influence on each other and on the whole, which itself in its turn exerts a reciprocal formative influence on all its constituent parts (Denton 2002: 335). This interaction between the whole and its parts could be viewed as a biochemical manifestation of the interaction between the One and the many that constitutes the cosmos, as we have discussed earlier.

10.16.1 Protein folding

The process of protein folding appears as matter drawn into a pre-existing Platonic mould (Denton 2002: 332). The amino acid sequence of the protein ‘searches’ for increasingly stable intermediates towards the deepest energy minimum for that sequence. This is analogous to a ball finding its way down the sides of an irregularly shaped bowl to the bottom, the latter representing the free energy minimum of the fold. The standard claim that the amino acid sequence determines the three-dimensional form of a protein is a mechanistic interpretation of the folding process, Denton asserts (2002: 332). The latter process is more accurately depicted in Platonic terms, in which the prior laws of form determine which amino acid sequences can fold into a stable three-dimensional form. As we noted earlier, Aristotle similarly employs the analogy of a pre-existing plan of a house that molds the building materials into conformity with the plan. Thus, although the bricks and stone come chronologically before the house, logically the form of the house comes first (Denton 2002: 332).

It has been observed that the three-dimensional conformations of protein folds are quite resistant to evolutionary changes in their amino acid sequences. The laws of physics allow only a limited number of folds, yet numerous apparently unrelated amino acid sequences can fold into same the form. This self-organisation of the same fold from very different amino acid sequences confirms the Platonic primacy of the protein fold over its material constituents (Denton 2002: 334). Moreover, the robustness of protein folds holds definite evolutionary implications, being a natural intrinsic feature of the folds and not a secondarily evolved feature. In this way the folds provide the evolutionary process with stable structures upon which to build more complex structures and functions (Denton 2002: 334).

In view of the above-mentioned facts it could be stated that the 1000-odd protein folds represent a physically determined bottle-neck through which protein evolution had to pass. This would also be the case on any Earth-like planet where proteins are constructed out of the same twenty amino acids. According to researchers in protein evolution, selection requires a detectable proto-function to begin with. This admission implies that selection has to be preceded by a stable scaffold to hang the function on (Denton 2002: 337). For instance, Dean Kenyon and Gary Steinman argued in their *Biochemical Predestination* (1969) that the ultimate development of a living cell is determined by the physical and chemical properties possessed by the starting compounds from which these systems evolved (Denton 2002: 338). That is to say, cells develop according to natural law and not random processes.

In summary, the protein folds represent a finite set of around 1000 natural forms determined by the laws of physics, like atoms and crystals. Therefore they do not conform to the Darwinian notion of organic forms as contingent, functionally contrived assemblages of matter. The protein folds thus represent the first case in the history of biology where a set of complex organic forms can be shown to be unambiguously lawful natural forms in the classic, pre-Darwinian sense. It thereby challenges the Darwinian orthodoxy that all complex organic forms are contingent, artifact-like products of selection (Denton 2002: 338-339).

10.16.2 Further evidence

Further biochemical evidence in favour of lawful evolution is found in microtubular forms and cell forms. According to researchers, the bipolar aster arises from the self-organisation of microtubules and molecular motors, in other words from the intrinsic characteristics of its parts. Therefore microtubular forms represent another set of lawful forms arising spontaneously out of the intrinsic properties of their basic material constituents (Denton 2002: 339). Microtubules are major structural components of eukaryotic cells, and their organic importance is evident from the fact that microtubules form the mitotic spindles that bind the chromosomes during cell division (Swift 2002: 361).

In addition, the cell form of *Tetrahymena* has remained basically unchanged for around a billion years among a set of species named the *Tetrahymena* swarm, despite the fact that their molecular constituents vary enormously. We thus observe an invariance of cell form with a marked variation in its building blocks, which suggests that certain features of the *Tetrahymena* cell form might be lawful non-functional structures, formed by physics rather than selection (Denton 2002: 340). Another example is the extraordinary ability of ciliate cells like *Stentor* to recover their ‘proper form’ after micro-surgical manipulations. It is possible, Denton suggests, that the whole cell is behaving like a natural form, searching conformational space (2002: 340).

10.17 Conclusion

The universe of protein folds represents a Platonic universe as in pre-Darwinian biology, Denton concludes. It appears that functional adaptations are secondary modifications of the essentially invariant givens of physics. That is to say, their evolution takes place by law, not by selection for a function. ‘It is a universe where abstract rules, like the rules of grammar, define a set of unique immaterial templates which are materialized into a thousand or so natural forms – a world of rational morphology and pre-ordained evolutionary paths’ (Denton 2002: 340). There could be no doubt that Plato would have concurred wholeheartedly with this scientific statement.

11: Directed evolution

11.1 Introduction

Since the late nineteenth century one of the most important scientific alternatives to Darwinism has been orthogenesis, or directed evolution. The first part of ‘orthogenesis’ is derived from the Greek *orthos*, which means straight, as ‘in a straight line’; also right, true, exact, or genuine (Liddell & Scott: 497). The term orthogenesis was coined by the German zoologist Wilhelm Haacke in his work *Gestaltung und Vererbung* (1893), with a primary meaning that correlates with the modern phrase ‘constraints on variation.’ He presented a theory of heredity that was close to the ‘germ plasm’ theory of August Weismann, but differed from the latter by viewing the genetic material as combining in such a way that organisms can only vary in definite directions. This capacity was termed *orthogenesis* by Haacke, who contrasted it with *amphigenesis*, the ability to vary in every possible direction (Popov 2009: 205-206). The notion was popularised by another German zoologist, Theodor Eimer, who had been a student of Weismann but came to reject his mentor’s adherence to Darwinism. Based on his extensive study of butterflies, Eimer published his findings in *Orthogenesis der Schmetterlinge* (1897). In this work it was argued that evolution occurs almost exclusively as development along definitely determined lines (Bergman 2009: 141).

The theory of orthogenesis postulates that ‘living organisms have a predisposition to vary in certain directions, and this very predisposition determines the trend of evolution, first of all, irrespectively from adaptation and selection; as the crystals grow taking a certain form, so phylogenetic trends evolve following their internal laws’ (Popov 2009: 205). In other words, evolution occurs due to internal forces that limit variation in specified directions. When a maximised structure has evolved, there is no further evolutionary change and stasis sets in (Bergman 2009: 140-141). The following distinction has been made between orthogenesis and the related theory of convergent evolution: ‘orthogenesis postulates parallel evolution driven by nonadaptive trends in related species; in contrast, convergence is a theoretical process by which unrelated organisms independently adapted to similar habitats or lifestyles’ (Bergman 2009: 143). The ubiquitous reality of convergence will be demonstrated in the next chapter.

It was recognised by an opponent of orthogenesis, Theodosius Dobzhansky, that ‘If evolution is orthogenesis, then it is what the etymology of the word “evolution” implies, i.e., unfolding of preexisting rudiments, like the development of a flower from a bud' (1967: 117-118). The pioneering Neo-Darwinist also mentions the evidence of progress and directionality found in the living world as a whole. Exceptions thereto are groups such as various parasites whose evolution was retrogressive, e.g. degeneration of the nervous system, or groups in which evolution has produced endless variations on the same theme. Yet the net outcome of evolution is that the Earth is no longer populated by single-celled or simple multicellular organisms only. Instead we observe numerous complex organisms with body structures that are comparable to works of art, as well as organisms with highly developed nervous systems, which enable them to dominate their environment to some extent. Dobzhansky adds that orthogenesis is a hypothesis striving to explain the causes of evolution, and not a summary description of the evolutionary history of the living world (1967: 119).

However, in the face of the evidence just mentioned it is averred by Dobzhansky that the harmfulness of most mutations demonstrates the absence of guidance in evolution. In his words: 'At the level of mutation, evolution is neither directional nor oriented nor progressive. It is the very antithesis of orthogenesis. Mutation alone would cause chaos, not evolution. Natural selection redresses the balance' (1967: 122). In classical Darwinian fashion, natural selection is thus called upon to redress the alleged deficiencies of other evolutionary mechanisms, such as mutation. More recently some Neo-Darwinists have tried so hard to find a selectionist explanation at any price, that even the finest details of the vein structure in the wings of fruit flies have been attributed to natural selection (Popov 2009: 213).

Nonetheless, it cannot be denied that adaptation plays a significant role in micro-evolution. The case of the Galapagos finches is an example of undirected yet adaptive biological change (Denton 1998: 287). Some of their species comprise the genus *Geospiza*, and genetic studies have confirmed Darwin's hypothesis that they are all descended from a single species that arrived from South America (Cooke *et al* 2008: 353). As the dominant birds on these islands, the finches have diversified to occupy many ecological niches. Due to their small size and the distances involved there is limited breeding between the various island populations. However, it has been established that the finch species regularly produce hybrid offspring. This hybridisation implies that their differences in morphology and behaviour are attributable to gene segregation. Be that as it may, the Galapagos finches should be recognised as a case of limited evolution in which natural selection did play a role in their diversification from a common ancestor (Swift 2002: 227, 377).

11.2 Historical background

During the nineteenth century the arguments in favour of directed evolution were based mainly on the restricted number of directions in variation, such as the existence of non-adaptive characters, the phylogenetic regularities as evinced by the fossil record, and the phenomenon of parallel evolution (Popov 2009: 205). The much-neglected Alfred Wallace, who shared the formulation of the theory of natural selection with Charles Darwin, eventually became a proponent of directed evolution. Noting that the fertilised cell nucleus is the seat of heredity and development, the English naturalist posed the following pertinent questions regarding causality (Flannery 2011: 147-148): What is the agency that sets in motion a whole series of mechanical, chemical, and vital forces, and guides them at every step to their destined end? What power gave life to the living protoplasm out of which the cell consists, and organised the highly differentiated nucleus? In cell division, what power determines the early cell-mass to assume well-defined shapes? Who or what guides the atoms of protoplasmic molecules into new combinations chemically and new structures mechanically (e.g. muscle and bone)? It is then reasoned by Wallace, 'But this orderly process is quite unintelligible without some *directive organising* power constantly at work in or upon every chemical atom or physical molecule of the whole structure, as one after another they are brought to their places, and built in, as it were, to the structure of every tissue of every organ as it takes form and substance in the fabric of the living, moving, and, in the case of animals, sensitive creation' (quoted in Flannery 2011: 148). Wallace thus suggests that the complexity of the cell cannot be explained in terms of matter and mechanism only, but is due to a directed cause (Flannery 2011: 28). Wallace's notion of a directive organising power indwelling every atom and cell evokes, albeit in scientific terminology, the Hellenic notion of the indwelling reason-principles (*logoi*) in all existing things.

In the early twentieth century the theory of orthogenesis began receiving increasing support from the results of experimental breeding with various plant and animal species. Among its pioneers was the American zoologist Charles Whitman, who studied the variation of pigeons extensively. His scope was wider than that of the founders of genetics, since his research also included phylogenetic, embryological, and taxonomic studies (Popov 2009: 206). Whitman concluded that the variability of pigeons display various regularities which confirm the reality of orthogenesis. For instance, a reduction of pigmentation in their plumage was obtained step by step over several generations in order to produce white pigeons. Remarkably, 'Such a reduction always takes place in a definite direction: from forepart of the body through the spotty variant and the variant with two stripes on wings. The pigment was not lost evenly and gradually in the whole surface of the pigeon, and it did not disappear in any other direction' (Popov 2009: 206). If the Darwinians were correct with their stance on infinite variability, then the pigeon-breeding would not have produced such a directed change in coloration.

At the same time as Whitman's work, the eminent palaeontologist Henry Osborn also advocated orthogenesis. He argued that parallel evolution, also known as convergent evolution, served as convincing evidence for orthogenesis. Convergence refers to the independent development of similar structures in unrelated groups of animals. For example, wings have evolved independently at least three times, among pterodactyls, birds, and bats.[41] Examples such as these convinced Osborn of the existence of an orthogenetic inner drive that produced remarkably similar structures even in widely different environments (Bergman 2009: 142). Osborn viewed evolution as an explosion out from an ancestral form, such as occurs in adaptive radiation.[42] Moreover, once a structure has reached a certain level of perfection its evolution comes to an end. Therefore, Osborn argued, it is impossible for an organism to adapt to a different physical environment. This reasoning explains the existence of so-called living fossils, which have undergone little change since their first appearance in the fossil record (Bergman 2009: 141). Perhaps the most striking instance of such a living fossil is the reef-building bacteria known as stromalites. Appearing in the fossil record around 3.5 billion years ago, they are also known as blue-green algae. Stromatolites were formed mainly by photosynthesising colonial cyanobacteria and were the dominant life-form on Earth for an estimated two billion years. Astonishingly, living stromalites are still found today, for example at Shark Bay in Western Australia (Cooke *et al* 2008: 22).

A Russian contemporary of these American scientists, Lev Berg, asserted that the variation of characters in an evolutionary lineage follows a definite course, like an electric current moving along a wire (1969: 110). In the plant kingdom a gradual reduction of sexual generation and a

41 Interestingly, although both feathered birds (e.g. *Archaeopteryx*) and winged reptiles (e.g. *Pterodactylus*) first appear in the Jurassic period, their development occurred along opposite principles, as noted by Alfred Wallace: that of birds on the principle of condensation and specialisation of the fore-limb for flight by means of feathers; and that of reptiles by extension of one digit to support the wing-membrane (Flannery 2011: 84).

42 However, the notion of adaptive radiation has been criticised as being an imposition of an evolutionary interpretation on the appearance of morphologically related groups, such as jawed fishes and flowering plants, in the absence of common predecessors. The retropolation of adaptive radiation at lower taxonomic levels to higher levels is therefore erroneous (Swift 2002: 295).

corresponding increase of asexual generation has occurred, ranging from mosses to ferns and gymnosperms. This is evident from the well-developed prothallus of terrestrial ferns and horse-tails, to the reduced prothallus in heterosporous ferns and club-mosses, to the sporophyte of gymnosperms. A definite course of evolution is thus displayed in the reduction of the gametophyte – from a flourishing condition in mosses, to a gradual decline in ferns, to a complete disappearance in gymnosperms, to its final replacement by the sporophyte in angiosperms. Significantly, these are not links of one genealogical chain (ferns, for example, are older than mosses) but various genetic branches (Berg 1969: 118-121).

Turning to the animal kingdom, the Russian zoologist found evidence for directed evolution in many long-term evolutionary trends among vertebrates. Examples include the evolution of teeth among reptiles and mammals; the gradual ossification of the vertebral column, for example in fishes; the reduction in the number of bones in the skull; the transformation of a two-chambered heart into a three- and four-chambered organ, with a corresponding increase in the complexity of the circulatory system; and the evolution of the brain (Berg 1969: 121). Among vertebrates the skull, vertebral column, and extremities developed in a definite direction, without the presence of chance variations being selected by nature. In the evolution of arterial and venous systems in vertebrates, i.e. from lampreys and fishes to mammals, one finds that the number of pairs of aortic arches gradually diminishes. Finally, the resemblance between crocodiles and birds in respect of the heart is also manifested in the structure of the brain (Berg 1969: 124-125, 127). As remarked by the French zoologist Pierre Grassé, 'The existence of oriented lines is a fact, and not a theoretical view; a line can only be identified and exists solely because it embodies a given trend appearing in individuals which derive from one another and succeed one another in time' (Davison 2000: 33).

The course of evolution is depicted as follows by Berg: 'a given group of organisms in the course of time breaks up into forms which either repeat the course of development of the existing forms, or follow a direction in which will subsequently develop still more highly organised groups' (1969: 163). That is to say, there are a restricted number of definite possibilities, while allowing for an immense variety in details. According to Berg internal causes predominate over the environment, for example in leading an organism to destruction or in the entire process of embryonic development. Also, in sea dwellers such as ammonites, the same mutations are produced in both stable and changing environments. The insignificant influence of climate on organic evolution is demonstrated by the glacial epoch, which had a catastrophic effect on the geographical distribution of species through extinction or migration, but very few new forms were produced by nature (Berg 1969: 114, 116). Sometimes an organism produces the same characters in different localities. For example, from the barley *Hordeum vulgare* a new form has been produced through regressive mutation, appearing in hereditary forms in both the sub-alpine Caucasus and the continental Don regions (Berg 1969: 118). The observed direction in evolution is therefore primarily due to internal factors, while environmental factors play a secondary role.

According to Henry Osborn there is no palaeontological evidence that the fit originates by selection from the fortuitous. In support of this contention Berg mentions the case of the deer (genus *Cervus*), which developed from different species in the Miocene. That is to say, the deer evolved polyphyletically, which is irreconcilable with the principle of selection, since the former excludes the operation of chance in the production of characters. Therefore, ‘Every polyphyletic genus affords the most obvious evidence in favour of the assumption that development follows a definite course, that it could not proceed in any other way than the one it has taken, that variations are not infinite, but strictly limited in number, and that polyphyletic evolution is not the exception, but the rule’ (Berg 1969: 127-128). This view is diametrically opposed to the Darwinian stance on monophyletic evolution, as noted earlier.

One of Berg’s Russian colleagues, the botanist Nikolay Vavilov, undertook an extensive study of cultivated plants. Vavilov discovered that in different species of cereals, parallel variations occur in the shape of the ears and the colour of the seeds. This phenomenon even occurs among unrelated plants, such as identical variations of the root form in beet, carrot and turnip. Furthermore, variations such as gigantism, dwarfism, fasciation, and albinism are found throughout the plant kingdom. This phenomenon of parallel variations even enabled the Russian botanist to predict the discovery of new plant forms: since lobate forms were known among pumpkins and melons, but unknown among watermelons, Vavilov predicted the discovery of lobate watermelons, which were duly found in south-eastern Russia. This event is reminiscent of Dmitry Mendeleev predicting the discovery of new chemical elements after he formulated the periodic law (Popov 2009: 206). Evidently the theory of directed evolution possesses predictive power, thereby meeting a crucial requirement for a scientific theory.

The phenomenon of parallel variability was known to Darwin, who ascribed it to a common origin of the species concerned. Vavilov agreed with Darwin on the common origin of homological series, but against the English naturalist he emphasised that there are defined directions in variability and therefore in evolution. ‘Moreover,’ as explained by Popov, ‘he [Vavilov] paid attention to the fact that different mutations could create identical phenotypes, i.e., the number of possible phenotypes is smaller than the number of possible mutations’ (2009: 207). It is not surprising that the eminent Russian proponents of directed evolution such as Berg, Vavilov and the botanist Sobolev collaborated with each other. Unfortunately their studies were limited by political conditions, as remarked by Popov (2009: 207), since Darwinism occupied the same place as Communism in Soviet biology. Nonetheless, during the 1970’s there was a revival of interest in Berg’s work among Soviet scientists, which led to the publication of some of his further writings on evolutionary theory (Popov 2009: 210-211).

In Germany the geneticist Viktor Jollos was led by his research data to argue in favour of orthogenetic mutations. He published an essay in 1931, showing that the wild type of the fruit-fly *Drosophila* produced a mutation of eye colour in the sequence dark → light → yellow, ivory and white. No other sequences were observed, so that Jollos termed this phenomenon ‘directed mutation’ (Popov 2009: 207). Tragically, Jollos was forced to emigrate from National Socialist Germany in 1933 and died a few years later in America, while Vavilov died in a Soviet prison and Whitman died before his studies on pigeons could be completed.[43] The untimely deaths of these orthogenetic scientists thus contributed, albeit indirectly, to the rise to dominance of the Neo-Darwinian synthesis with its emphasis on random variations (Popov 2009: 207-208).

Remarkably, most of the scientists who played leading roles in the formation of the Neo-Darwinian synthesis strove to discredit indications of evolutionary constraints, due to their belief that selection could create practically anything (Popov 2009: 208). This denial of constraints in variation is especially evident in the work of Theodosius Dobzhansky and Ernst Mayr. In the first editions of their influential works these scientists devoted entire chapters to the question of evolutionary constraints. However, in further editions and writings this question becomes reduced and finally disappears altogether (Popov 2009: 209). For instance, in his *Genetics and the Origin of Species* (1937) Dobzhansky included a table showing the combinations of five characters, each with two variations. This gives a total of 32 possible combinations, but Dobzhansky shows eight, with Mayr citing the data in his *Systematics and*

43 Berg was an exception, having been an honoured member of the Soviet academic establishment due to his monumental work on the fishes of the Soviet Union.

the Origin of Species (1942) to demonstrate the 'abundance' of variability. The glaringly obvious fact that the eight combinations found in nature were 24 short of the possible total eventually led both authors to omit the example from subsequent editions of their works. In his *Animal Species and Evolution* (1963) Mayr attempted to shelve the question of evolutionary constraints by stating that knowledge of how genetic variation is produced is less important for the understanding of evolution than to know how natural selection deals with it. Thus did the Neo-Darwinists comply with Darwin's dictum (in *The Variation of Animals and Plants under Domestication*, 1883) that variability is in quite a subordinate position compared with selection (Popov 2009: 210).

The notion of direction in the evolutionary process also found support from Arthur Koestler in his *Ghost in the Machine* (1967). The Hungarian-born author cites scientists such as Ludwig von Bertalanffy (a founder of general systems theory), who viewed the evolutionary process not as based on selection within a chaotic mass of mutations (as Darwinism holds), but as governed by definite laws; and Helen Spurway who argued that the evidence from homology suggests a restricted mutational spectrum which determines the possibilities of evolution (Denton 1998: 272). Accordingly, given our planetary conditions, atmosphere, energies and building material, life from its first inception could only progress in a limited number of ways. Koestler concludes that the evolution of life is a game played according to fixed rules, which are inherent in the structure of living matter (Denton 1998: 272).[44]

11.3 Constraints on variation

The theory of directed evolution is closely allied with the notion of constraints on variation. In his informative essay *The Problem of Constraints on Variation*, the Russian biologist Igor Popov noted that the Darwinian scheme of mutation-selection contains a gap, namely the distance between the mutation and the phenotype which is exposed to selection. This was recognised by some Darwinians, who then employed developmental biology to fill the gap, since this discipline exposed the special forces influencing the path from gene to phenotype. One of these 'gap-filling' processes is the constraint to the number of possible directions of variation (Popov 2009: 213). For example, the differences in pigmentation in various

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[44] This reference to biological evolution as a game reminds one of the classical Indo-European view of the world as a game (Sanskrit *lila*) that the divine Spirit (*Atma*) plays with itself. Proclus related this notion to the activity of the gods and depicted it in evocative terminology: 'The laughter of the Gods must be defined to be their exuberant energy in the universe, and the cause of the gladness of all mundane natures' (quoted in Perry 1991: 34).

segments of the fruit fly *Drosophila* interact strongly with developmental genes. These interactions are unlikely to have arisen due to natural selection, and are therefore better interpreted as evolutionary constraints (Popov 2009: 214).

It was argued by Darwin that the variability of organisms is infinite (*Origin*, Chapter 4; 1998: 99). That is to say, for Darwin biological tissues possess an innate 'plasticity' which is fundamentally unlimited (Swift 2002: 299). Berg objected that this notion had been refuted by the palaeontological evidence. For example, among ammonites a limited number of variations are arranged in definite lines. This is illustrated by the transformation displayed in the species *Phylloceras heterophyllum*, in which we observe an ever-growing complexity of the lobate line from more ancient to more recent deposits (Berg 1969: 25, 385). Furthermore, the fossil remains of the molar teeth of mammals indicate that the majority of teeth are derived from a primitive type of tritubercular teeth, in orders as varied as Insectivora, Ungulata and Primata. Thus the complexity of the molars develops in strict accordance with a law, with the supplementary tubercules and their variations appearing in a determined order and a definite position (Berg 1969: 25-26). In addition, it was unknown in Darwin's time that the apparent 'plasticity' of tissues results from underlying genetic and biochemical mechanisms. We now know that morphological variations arise through different combinations of genes; in other words, the shuffling and segregation of existing genes. This finite pool of available genetic material limits the extent of possible variations (Swift 2002: 299, 314).

Neither Darwin nor the Neo-Darwinists were able to solve the problem of constraints on variation, Popov remarks (2009: 216). Instead, they strove to conceal or discredit any data related to constraints. Of course, they had good reason for doing so: 'Otherwise, if recognized, the limitation to variation will always and everywhere affect evolution, and this means that evolution is a movement on rails, instead of wandering through the vast space of adaptation. If that is the case, selection should be considered a destructive force. Moreover, such a standpoint is not Darwinism anymore, it is orthogenesis, and it cannot be included into the Darwinian paradigm' (Popov 2009: 216). The image of evolution as a movement on rails is in our view a useful one, since it also accommodates the phenomena of evolutionary dead-ends (= a railway terminus) and extinctions (= an accidental derailing).

Against the Darwinian notion of infinite variability, Lev Berg emphasised that nature can only produce new forms from genotypical, not phenotypical, material (1969: 27). That is to say, mutations, or inherited variations, are required. Furthermore, the observed number of mutations is so limited that there is no scope for selection to operate in. Berg adds that infinite variations would have led to deformations and monstrosities being the norm in nature, and well-adapted beings the exception. However, this possibility is contrary to both the fossil record and current observation. Instead, 'An organism is a stable system, in which a tendency towards variation is confined within certain limits by inheritance... It would be impossible to conceive how such complex organs as the eye, the ear or the pituitary body could properly exercise their functions, if they were the seat of an infinite number of variations, from which it would be left to chance to select the most efficient' (Berg 1969: 27). On all the steps of the phylogenetic ladder beings perfectly adapted to their environment are found, Berg continues, and not the monstrous forms which would have followed from infinite variability. Thus the extraordinary polymorphism displayed by wheat, rye, barley and lentil is due to the redistribution of the same characters, while the boundary-lines separating the different species remain inviolable. This intra-specific variability is determined by law, so that similar forms are found among different species (Berg 1969: 29-30). It is also noteworthy that hybridisation, or new forms produced by means of crossing, is irrelevant to evolution, since hybridisation is only successful within the limits of one species. However, exceptions occur, as in the case of crossings between *Viola tricolor* and *Viola arvensis* (Berg 1969: 31-33). This could be viewed as botanical confirmation of the adage that exceptions prove the rule.

That constraints on variation similarly apply to artificial selection has been demonstrated by the horticulturist Luther Burbank in his plant-breeding experiments. He called it the Law of the Reversion to the Average, which states that plants and animals all tend to revert in successive generations toward a given mean or average. Through his experiments Burbank discovered the existence of a 'pull' toward the mean, which keeps all living things within some more or less fixed limitations (Davison 2000: 12). This phenomenon was also encountered by Ernst Mayr in his experiments with fruit-flies. He managed to markedly increase and decrease the number of bristles on their bodies, but without selective breeding the carriers of these extremes either died out or reverted to their average. As commented by Richard Thompson, 'These results reveal a major antievolutionary characteristic of species: when changes are pushed beyond a certain limit members of a species will become sterile and die out or else revert to their standard form' (1984: 45-46). Burbanks's Law is also demonstrated by the role natural selection plays when domesticated animals are returned to the wild. The deviant selected forms rapidly disappear in favour of the more standard types which more closely resemble their ancestors (Davison 2000: 33).

It was furthermore argued by Lev Berg that the phenomenon of phylogenetic acceleration provides striking affirmation that development occurs in a determined direction without the intervention of chance (1969: 73). Evidence confirming this is found in palaeontology, embryology and comparative anatomy. After surveying numerous examples from the plant, animal, and human kingdoms (e.g. *Homo neanderthalensis* and *H. sapiens*, of which the former had a larger brain), Berg concludes that (i) new characters arise not accidentally, but in accordance with law, (ii) the struggle for existence and natural selection had nothing to do with the development of these characters, and (iii) evolution proceeds in accordance with law, that is to say in a determined direction (1969: 107-108).

The notion of constraints on variation received significant buttressing from D'Arcy Thompson, whose epochal work *On Growth and Form* we touched upon in an earlier chapter. In it the Scottish polymath depicted an immense variety of organic forms in terms of mathematical patterns and physical laws. This approach enabled Thompson to describe in considerable detail the possible limitations to organic forms, determined by their physical conditions (Popov 2009: 208). Although Thompson did not engage in anti-Darwinian polemics in this work, he disagreed on various points with Darwinism. For example, with his holistic view of organic reality Thompson rejected the notion of the independence of single characters, arguing instead that all the parts of an organism are correlated with each other. In addition, Thompson rejected the adaptationist explanations of organic forms such as the sponge-spicule and Radiolaria, asserting that their form is due to chemical and physical characteristics. Consequently, the Darwinian explanation of the evolution of their form in terms of a struggle for existence becomes meaningless (Popov 2009: 208).

An apparently universal feature of orthogenesis is that new life forms typically appear as small organisms which subsequently become larger and more specialized (Davison 2000: 37). Examples of this tendency are preponderant among dinosaurs, titanotheres and ammonites. This was discussed by the palaeontologist Otto Schindewolf, who identified three phases in the evolutionary process. The first phase, *typogenesis*, involves the rapid establishment of new forms. The slower, second phase, *typostasis*, entails elaboration and diversification of the newly established forms. The third phase, *typolysis*, is characterized by gigantism and over-specialization. Not surprisingly, therefore, this phase ends with extinction (Davison 2000: 37-

38). This scheme by Schindewolf serves to explain various trends in the fossil record that appear to be incompatible with natural selection and adaptation. Many cases of extinction have been attributed to the evolution of characters that were excessive for their possessors. For example, the massive reptiles of the Cretaceous era required enormous quantities of food merely to survive. In the case of the extinct Irish elk (*Megaloceros*) the antlers were so large that the animal had difficulty walking. Another example, which was thoroughly studied by Osborn, is the rhinoceros-like titanothere, whose nasal horns evolved to such an extent that they seriously interfered with adaptation (Bergman 2009: 141).

A genetic basis for specialisation has been postulated by David Swift, in terms of which this phenomenon is not due to the gain of genetic material, but to its loss. Accordingly, in some cases evolutionary success has been due to the intensive selection of a very limited set of genes, which in turn increases susceptibility to extinction when circumstances change. A prime example thereof in the present is the cheetah (*Acinonyx jubatus*), the fastest land mammal on Earth. With its long legs and non-retractile claws this big cat is well-adapted to living in open grassland, where its speed enables it to run down the smaller antelopes that comprise the bulk of its prey. The cheetah's reputation as the most specialised living cat is probably due to its low genetic diversity (the lowest among the big cats), for which natural selection had to compensate by dispensing with unnecessary features, such as the retractile claws of other cats (Swift 2002: 253-254, 294). However, due to the (human-caused) loss of its specialised habitat, the cheetah's conservation status has become vulnerable (Cooke *et al* 2008: 153), so that is unlikely to survive in the long run outside protected areas.

In support of orthogenesis, Lev Berg noted the gradual reduction of the hind limbs and pelvis in aquatic mammals of the orders Cetacea (whales) and Sirenia (dugong and manatees). The fossil record also shows the directed development of the Nautiloideae from forms with a straight shell to those with a spiral shell. If the survival of the more progressive spiral forms was due to selection, then the entire group would have become extinct as being unfit before the formation of spiral forms commenced (Berg 1969: 128-131). The shells of various invertebrate groups have often been evoked as indicating directed evolution, beginning with the Russian entomologist Yuri Filipchenko (who also coined the terms micro- and macro-evolution) in the 1920s. Noting that the shells of foraminiferans are so similar to those of extinct cephalopods that they were initially considered to be molluscs, Filipchenko came to the conclusion that 'the laws of growth and step-by-step enrollment of primary straight shells are probably equal, irrespectively of the fact if this shell belongs either to a unicellular rhizopod or to a highly developed representative of mollusks' (quoted in Popov 2009: 212). This implies that evolutionary constraints are due to organic lawfulness.

The evidence from shells was likewise employed by Stephen Jay Gould and Richard Lewontin in a 1979 essay which bears the impressive title *The spandrels of San Marco and the Panglossian paradigm: a critique of the adaptationist program*. The Panglossian paradigm refers to the adaptationist program that was popularised towards the end of the nineteenth century by Alfred Wallace and August Weismann. As explained by the authors, 'This programme regards natural selection as so powerful and the constraints upon it so few that direct production of adaptation through its operation becomes the primary cause of nearly all organic form, function, and behaviour' (Gould 2007: 419). In this essay the American scholars also refer to the work of the German palaeontologist Adolf Seilacher and his notion of 'architectural constraints', being morphological restrictions that were never adaptations. For example, the divaricate (i.e. branching) form of architecture occurs repeatedly in the shells of all groups of molluscs, as well as in the unrelated brachiopods. It manifests in a variety of structures, including raised ornamental lines, patterns of coloration, and incised grooves. Seilacher argued that most manifestations of this pattern are the result of a pattern of inhomogeneity in the growing mantle of the organism and are therefore non-adaptive. This is suggested by, for example, the colour patterns of clams that are invisible due to the animal living buried in sediments or remaining covered with a thick layer of periostracum. Their divaricate structure is therefore a fundamental architectural constraint, which could be useful to the organism but cannot be the result of adaptation (Gould 2007: 432-434).

A further constraint against undirected change is the genetic phenomenon of redundancy, as noted by Michael Denton. This entails organisms being reinforced by partially or totally redundant genes to guard against random mutational error. Organs such as the female vulva therefore develop by means of two or more quite different mechanisms, of which any one is sufficient to generate a perfect organ (Denton 1998: 337-338). This implies that organs cannot be radically transformed through a succession of small, independent changes as postulated in Darwinism, since simultaneous changes are required in various mechanisms. The same requirement applies to protein molecules, in which each atom co-operatively interact with all other atoms, so that the proteins form complex holistic systems (Denton 1998: 339-340). As a matter of fact, it has recently become evident in molecular biology that living systems are best understood in holistic or network terms, in which the properties of the networks are not merely the sum of the individual parts. Instead, the properties are emergent, so that the features of each network are only intelligible in a holistic way. For instance, in genomic databases it is not the genes alone, or the proteins encoded by the genes, but the interactions between the proteins and various other macro-molecular components in each cell that constitutes the network (Hewlett 2006: 182).

According to a study by Lev Yampolsky and Arlin Stoltzfus published in 2001, the existing models of population genetics are biased since they assume *a priori* that variations will be available and thus underestimate mutation pressure. In reality, evolution is driven by mutation which produces novelty. The authors concluded that the phenomena of homoplasy, parallelism and directionality are due to internal factors (Popov 2009: 212) – as Berg had insisted 80 years earlier. In a more recent study (2003), Elena Kovalenko collected a quantity of empirical material which did not correspond with Darwin’s view on the properties of variability. The Russian scholar found that the number of available variations is significantly less than the number which could be calculated theoretically. For example, mass breeding and field-work revealed that various species of frog (genus *Anura*) showed 45 variations out of the 288 possible ones. Moreover, for each species not only the number and frequency but also the qualitative structure of variations were constant: in samples from different populations, in their offspring, and in both young and adult frogs. Kovalenko concluded that natural selection could play a limited role as an exception, with the species still represented by those variations which have a higher probability in the spectrum of its variability (Popov 2009: 215-216). That is to say, natural selection does contribute to evolution, but in a secondary role after mutation.

One of the most important thinkers on evolutionary theory today is the palaeontologist Simon Conway Morris, who achieved renown with his work on the Burgess Shale fossils. This Canadian site contains the most extensive fossil deposits of the Cambrian era, with more than 60 000 fossils having been recovered since its discovery in 1909 (Cooke *et al* 2008: 27). In his book *The Crucible of Creation* (1998), Conway Morris argues that these early animals became extinct because they were ill adapted to their environment. The latter is always the result of physical and biochemical laws, which constrain the types of organisms to develop within certain limits. These laws will therefore ensure that the carbon atoms found in stars will eventually combine into long molecules capable of replication, that these molecules will build bodies sensitive to heat and light, and that these bodies will be capable of movement in their environment, with their sense organs situated towards the front end (Ward 2008: 66). In other words, the physical environment as such acts as a (ubiquitous) constraint on variations.

In a 2001 essay the biochemists Michael Denton and Craig Marshall argued that the evolution of biological forms has to a large extent been determined by physical law. This implies that the immense diversity of life-forms is underlaid by a finite set of natural forms that will recur anywhere in the cosmos where carbon-based life exists. Conway Morris concurs: ‘Not all is possible, options are limited, and different starting points converge repeatedly on the same destinations... The “landscape” of biological form, be it at the level of proteins, organisms, or social systems, may in principle be almost infinitely rich, but in reality the number of “roads” through it may be much more restricted’ (2003: 11). That is to say, due to physical and biochemical constraints there are a limited number of pathways that evolution can follow.

11.4 Biochemical evidence

More recent evidence in favour of directed evolution include the uniformity and speed of molecular evolution, and the rapidity of the major morphological transitions (Denton 1998: 265). Apparently unaware thereof, the biologist Jerry Bergman averred that the theory of orthogenesis has been largely abandoned, since no known mechanism exists to account for an endogenous perfecting force (2009: 144). However, Michael Denton contends, the evidence from genetics suggests that the whole pattern of evolution might have been written into the DNA of all fauna and flora from the outset. Thus every living organism is specified in a precisely determined way through a set of instructions encoded in the sequence of bases in its DNA. The available evidence thus implies that DNA is fit not only for heredity but also for directed evolution (Denton 1998: 275). Also suggestive is the fact that biological information flows in only one direction (as Weismann had shown), namely from genes to organism. To be more precise, information flows from DNA to protein, that is to say from linear DNA space to three-dimensional morphological space. In the words of Denton, ‘This unidirectional flow of information from DNA to organism is clearly “fit” for directed evolution’ (1998: 276). This reasoning evokes the Pythagorean and Platonic dictum that the cosmos arises through a progression from two-dimensional geometrical surfaces to three-dimensional solid bodies.

In contrast, Neo-Darwinian orthodoxy insists on the spontaneity of mutation, which is viewed as comprising accidental, undirected, and random events, and moreover unorientated with respect to adaptation (Denton 1998: 285). The only evidence for spontaneous mutation is provided by the Luria-Delbrück experiment conducted in 1943, which found that in the bacterium *Escherichia coli* genetic mutations arise in the absence of selection. This was interpreted by the Darwinists as confirmation of their theory that natural selection acting on random mutations applies not only to higher organisms, but to bacteria as well (Wikipedia: Luria-Delbrück experiment). However, Delbrück later admitted that specifically adaptive mutations are possible. Whichever way, Denton remarks, it is impossible to demonstrate experimentally that all of the changes in DNA sequence over the past four billion years of evolution have occurred spontaneously, although some undoubtedly did (1998: 286).

It is also noteworthy that unlike evolutionary change at the morphological level, where it is only possible to move from one adaptation to another through functional intermediates, a DNA sequence does not have to be functional in order to survive and be reproduced. In addition, DNA sequences are not under any selective surveillance while in ‘evolutionary transit’ over succeeding generations. ‘Thus, new organs and structures that cannot be reached via a series of functional morphological intermediates can still be reached by a change in DNA sequence space’ (Denton 1998: 278-279). It could therefore be stated that DNA is eminently fit for directed evolution on account of the following: (i) the proximity of all life forms at DNA level, and that all known sequences can be interconverted in small natural steps; (ii) the unidirectional flow of information from genotype to phenotype; and (iii) since functional DNA sequences can be derived via functionless intermediates, a new phenotype or organ can be generated by saltation, i.e. a mutational ‘jump’ (Denton 1998: 279).

The vital importance of DNA to an organism is evident from the fact that it contains all the information necessary for the growth of the organism, by means of cellular multiplication and differentiation, acting through the regulated expression of this information (Swift 2002: 306). And since genes thus direct all of the morphological development of an organism from egg cell to adult, there is in principle no reason why genes cannot also direct evolutionary change (Denton 1998: 279-280). During the process of development the genes are rearranged at precisely predetermined times, for example the development of the immune system. Thus, ‘most genetic change underlying evolution, especially in higher organisms, has been largely a matter of the rearrangement of preexisting genes rather than the emergence of new genes’ (Denton 1998: 280). In addition, variations in the sequence of the base pairs A-T and C-G can be explained by directional mutational pressure and selective constraints which are inherent in the genome itself (Denton 1998: 281). Apparently genetic material acts as efficient cause in both genotypical and phenotypical development.

However, we contend that to attribute the entire evolution of the organic realm to DNA programming without regard for the role of natural selection is erroneous. It has been noted in this regard by Martinez Hewlett that a number of surprising discoveries were made during the course of the human genome project, which lasted from 1986 until 2001. First, there are large regions of DNA which contain no genes; they are therefore not involved in protein sequencing. Second, the total number of human genes amount to between 20 000 and 25 000, which is not much different from the total genes of the fruit-fly. Third, it was found that genes are not definable in terms of their DNA sequence only. These results appear to confirm the argument by Michael Polyani that, in principle, life cannot be reduced to the chemistry of DNA. Thus did molecular biology finally arrive at the conclusion that genetic information is irreducible to chemistry, thereby thwarting the project by Francis Crick and others to explain everything biological in terms of physics and chemistry (Hewlett 2006: 180-181).

The following genetic evidence suggests molecular direction. Firstly, the rate of evolutionary substitution (i.e. the average number of changes in DNA per generation since two species separated) and the rate of mutation (i.e. the changes in DNA sequence over one generation) are almost identical. This implies that different DNA sequences between species are generated by mutation, so that other factors such as natural selection played a minor role (Denton 1998: 288-289). Neo-Darwinists have tried to explain this phenomenon by the so-called ‘junk’ hypothesis, which was postulated by Richard Dawkins. In terms thereof, much of DNA is non-functional junk and even parasitic on the host organism (Denton 1998: 289). Remarkably, this ‘silent’ DNA comprises the bulk of the DNA in higher plants and animals, in some cases exceeding 90% of the total (Swift 2002: 131). Contrary to Dawkins’ claim, it has been established that messenger RNA comes not only from protein-coding genes but also from many other parts of ‘junk’ DNA. In addition, some of the ‘parasitic’ DNA contains a large quantity of transposon DNA. These are the so-called ‘jumping genes’ that jump from one chromosome to another, thereby contributing functionally useful diversity to genomes (Alexander 2008: 59-60). Evidence has also been found that non-proteincoding ‘junk’ DNA has informational characteristics similar to those of human language (Denton 1998: 290).

Secondly, the uniformity of molecular evolution is established by comparing gene sequences. For example, all the higher cytochromes (from yeasts and plants to insects and mammals) display an equal degree of sequence divergence from the bacterial cytochrome in *Rhodospirillum*. This implies that all their cytochrome genes have evolved at a uniform rate. The same uniformity is found in protein-coding genes, with very few exceptions (Denton 1998: 290). It is difficult to explain this ‘molecular clock’ in selectionist terms, Denton adds. For instance, human and salmon hemoglobins are equidistant from those of hagfish, in spite of the enormous morphological and physiological differences between the human and salmon organisms. These genetic discoveries provide indirect evidence that the mutational processes which are changing the DNA sequence of organisms are being directed, by an as yet unknown mechanism (Denton 1998: 291-292).

According to Stephen Jay Gould, the science of developmental biology demonstrates the conservation of basic pathways of development among phyla that have been evolving independently for at least 500 million years while being very different in basic anatomy, such as insects and vertebrates (1997: 4). Remarkably, the homeotic genes of fruit flies are also present in vertebrates, functioning in effectively the same way – their mutations disturb the order of the parts along the main body axis, for example the legs. In addition, the same gene conserves and mediates the major developmental pathways for eyes in animals as diverse as squids, flies and vertebrates, although the final products differ markedly. Moreover, the same genes regulate the formation of top and bottom surfaces in insects and vertebrates, although with an inverted order. Thus in vertebrates the spinal cord is placed above the gut, whereas in insects the main nerve cord is placed below the gut. Gould concludes that this genetic stability acts as a constraint upon the range and potentiality of adaptation, with such a constraint being at least of equal importance to the advantages of adaptation (1997: 4-5).

Darwin should be credited for his identification of the existence of variations and the role played by natural selection, David Swift suggests, but he was wrong in the unlimited extrapolation thereof, as if these factors could account for all morphological changes. Although micro-evolution is not only possible but inevitable, it can only take place within the limits imposed by the existing genetic material. Such evolution is substantially confined to genetic recombination and selection, and extending it to entail macro-evolution is nothing more than speculation, since the latter requires the formation of new, useful genetic material (Swift 2002: 383). In other words, for macro-evolution to occur a mutational jump is required, thereby producing new genetic material and the resultant morphological change(s).

11.5 Organic plenitude

Any observer of the natural kingdoms has to be struck by the remarkable diversity of life on Earth in spite of the existence of embryological, physiological, and evolutionary constraints. As remarked by Michael Denton, ‘The possibility that life on earth approximates to the plenitude of all possible biological forms is perfectly in keeping with the teleological thesis that the cosmos is uniquely prefabricated for life as it exists on earth’ (1998: 299). This plenitude had been noted in 1835 by the French naturalist Georges Cuvier, writing ‘Nature, inexhaustible in fecundity and omnipotence... has realised all those combinations which are not incoherent’ (quoted in Denton 1998: 301). According to the principle of plenitude (as we noted earlier), the actual existence of the universe must be as abundant as the possibility of existence. That is to say, no genuine potentiality of being can remain unfulfilled. This ontological notion is manifested per excellence among microbial life, since bacteria are found in virtually every ecological niche on Earth. Also in their biochemical diversity, bacteria apparently utilises every available reaction in energy metabolism (Denton 1998: 302-303).

Various examples of obvious constraints where all possibilities have apparently been realised are mentioned by Denton: (i) the hibernation strategies in butterflies, namely egg, caterpillar, pupa or adult; (ii) the incubation strategies of birds; (iii) the structural possibilities of antelope horns and Gastropoda shells; and (iv) the modes of organic movement, i.e. jet propulsion in air and water, gliding, flying, ballooning, walking, swimming, and by propeller in some bacteria (1998: 305-306). Among the ubiquitous viruses all conceivable ways of storing genetic information (i.e. RNA and DNA, each single- and double-stranded) are found. In addition, the only possible forms of hollow structures that can be constructed from single subunits, the cylinder and the icosahedron, are found among viruses (Denton 1998: 306).

Regarding the crucial bodily function of oxygen delivery, Denton notes that there are only two possible ways of delivering oxygen to the tissues of a terrestrial air-breathing organism: a circulatory system to convey dissolved oxygen via small tubes throughout the body, or a tracheal system of tubes to convey oxygen directly to the tissues. These alternatives are in fact employed by vertebrates and arthropods, respectively. The circulatory and tracheal systems of oxygen delivery are functionally (for example in terms of movement) best suited for larger and smaller organisms respectively, and are thus not accidental (Denton 1998: 310-311). In addition, these two systems are determined by physical constants such as the diffusion rate of oxygen in air and water, the density and viscosity of water, and so forth. As far as vertebrate lungs are concerned, there are again two different possible types: a bellows type in which air is inhaled and exhaled via the same passage, and a continuous throughput type in which air is inhaled and exhaled through different passages. These alternatives are actualised in terrestrial vertebrates and birds, respectively (Denton 1998: 312).

In his *Critique of Judgment*, Immanuel Kant wrote that the analogy between a large variety of animal forms, for example in their skeleton, suggests conformity to a general original plan (*Urbilde*) from which all are descended (Berg 1969: 156). It has been noted in this regard that the main body plans (German *Bauplanen*) of the animal kingdom appeared hundreds of millions of years ago, afterwards only changing but not producing new ones (Popov 2009: 213). In other words, there appears to be a common 'model' that provides a measure of structural continuity to the immense diversity of animal forms, although it is more apparent among animals possessing a higher level of consciousness such as birds and mammals. It finds expression, for example, in the symmetrical disposition of the body, the number of extremities and sensory organs, and the general form of the internal organs (Burckhardt 1974: 144). However, an interesting non-homology pertaining to skeletons has been noted by David Swift, namely that the vertebrae are formed embryologically in diverse ways for the different vertebrate classes. For example, in birds the vertebrae are formed through resegmentation of the somite pairs, which does not occur in mammals; in some amphibians the vertebrae develop from undifferentiated myotomal cells; in cartilaginous fish (e.g. sharks) and many of the 'primitive' bony fish (e.g. sturgeons) the vertebrae are formed from pairs of somite cells called arcualia; and in teleost fish (comprising most living species) the vertebrae develop in three distinct stages totally unrelated to those of the other classes (Swift 2002: 323-324). Clearly, the notion of directed evolution does not in the least preclude morphological variety.

Within these main body plans there are two radically different types of skeletal structure, namely endoskeleton and exoskeleton. Analogous to the breathing systems mentioned above, these skeletal types are actualised in vertebrates and arthropods. While an endoskeleton is better suited for larger animals, an exoskeleton is more useful to smaller animals (Denton 1998: 312-313). Also related to bodily size, the six legs of insects provide more stability during movement for smaller organisms than the four legs of vertebrates. Quite a variety of moving on legs is noted by Denton: humans walk and kangaroos hop on two legs, most mammals walk or run on four legs, insects on six legs, spiders on eight legs, and centipedes and millipedes on more than ten legs. It thus appears that two basic designs for terrestrial macroscopic life exist: a larger type with a circulatory system, lungs, heart, endoskeleton and four legs; and a smaller type with a tracheal system, exoskeleton and six legs. These basic designs are actualised in vertebrates and insects, respectively (Denton 1998: 313-314).

Despite this phenomenon of organic plenitude there are also gaps in the *scala naturae*. For example, intermediates are absent between the unicellular Protozoa and the primitive multicellular Metazoan groups such as Porifera (sponges), Coelenterata (jellyfishes) and Ctenophora (comb jellies). There is an enormous diversity in morphology and behaviour among both the Protozoa and these named groups, yet the gap between them is filled with only a few types of simple colonial Protozoa (Denton 1998: 314). This could be a necessary and not an accidental gap, Denton suggests, since simple life forms can be composed of one or many cells, but not of five or six cells. Other gaps in the scale of nature could be due to different lifestyles; for example, the lack of marsupial whales or seals could be attributed to the marsupial reproductive system being not suited for an aquatic lifestyle. In addition, many of the seventy major phyla have never generated large complex forms. For instance, the size of the flatworm is limited by the absence of a circulatory system, and thus every cell has to be near enough the body surface to receive oxygen (Denton 1998: 315).

11.6 Constraints on plenitude

Evidently there are limitations on the principle of plenitude. Since all the parts and organs of an organism are functionally interrelated, constraints on one organ system necessarily impose constraints on others. Denton writes, 'The need for functional integration and coherence if an organism is to be actualised is bound to restrict the functionally possible to a fantastically small subset of all conceivable organisms' (1998: 316). In other words, the functional integrity of organisms also imposes constraints on the evolutionary pathways. Furthermore, evolution can only proceed through functional intermediates, which is another constraint on the possibilities of life-forms. This implies that perhaps not all possible fully functional life-forms can be generated (Denton 1998: 317). In addition to this evolutionary constraint there are those associated with the process of development, namely embryological constraints such as sufficient oxygen and nutrients, which require cardiovascular and respiratory systems. An example thereof is the gradual transformation in the embryo of a simple contractile tube into the four-chambered heart of the adult mammal (Denton 1998: 317-318).

Thinkers of the early nineteenth century, such as Samuel Coleridge and Georges Cuvier, viewed an organism as a whole presupposed by all its parts. It was argued by Cuvier, for instance, that since organ systems are integrated wholes, no part of it can be modified without affecting the other parts. Therefore, Denton remarks, any major change in a component subsystem will require simultaneous compensatory changes of a highly specific kind in interacting components so that functional integrity is preserved. ‘Thus, gradual change resulting from the accumulation of a succession of minor independent changes is impossible’ (Denton 1998: 328). Yet the existence of contingency as an incidental cause has to be recognised, as was done by Aristotle. This is evident from the fact that the vast majority of mutations are deleterious to an organism due to integrative complexity, but a small number are beneficial without compensatory changes required (Denton 1998: 342). That is to say, evolution has largely taken place in accordance with law, although the role of contingency should also be recognised – as Plato did in the *Timaeus*.

Even such an ultra-Darwinist as Richard Dawkins admitted (in *The Blind Watchmaker*) the existence of constraints that restrict evolutionary change. But in true Darwinian fashion, the English biologist contends that in the case of a sufficiently large series of sufficiently finely graded intermediates, anything can be derived from anything else (Denton 1998: 330-331). However, Denton objects, this argument ignores both the functional constraints and the biophysical barriers to particular transformations, which no amount of intermediates can surmount. For example, all the viral capsids are either cylinders or icosahedrons (for the reason mentioned earlier), and it is thus physically impossible for intermediates to function. The position of the nervous system in animals is also suggestive: ventral for invertebrates and dorsal for vertebrates. Due to integrative complexity, no group of organisms exist which have a nervous system halfway between the front and the back (Denton 1998: 331-332).

Contrary to the early twentieth-century view (the so-called ‘beanbag genetics’), there is no one-to-one relationship between individual genes and character traits. Instead, as stated by Ernst Mayr, every character of an organism is affected by all genes and every gene affects all characters. Accordingly, the process of development of an organism is not genetically compartmentalised, so that particular organs are not specified by particular sets of genes (Denton 1998: 332-334). We again encounter a holistic reality, arising in the organic realm due to physical and chemical laws regulating the unfolding of the One into the many.

12: Convergent evolution

12.1 Introduction

In the highly informative and beautifully illustrated *Encyclopedia of Animals* edited by Fred Cooke and other biologists, the term ‘convergent evolution’ is defined as follows: ‘The situation in which totally unrelated groups develop similar structures to cope with similar evolutionary pressures’ (2008: 588). The biochemist Denis Alexander defines convergence as ‘the repeated evolution in independent lineages of the same biochemical pathway, or organ or structure’ (2008: 326). According to Lev Berg there is no real difference between parallelism, convergence and homology, since all characters arise in accordance with certain laws (1969: 159-160). A leading Russian Neo-Darwinist, L. Tatarinov, admitted that the reasons for the abundance of parallelisms remain unclear: ‘Random hereditary variation should cause a rather uniqueness of features, even in the case of the adaptation of related species to a similar environment’ (quoted in Popov 2009: 215).

The phenomenon of convergence is indeed problematic to Darwinism, which entails divergent evolution, so that similarities are ascribed to homology and convergence is viewed as rare and accidental (Berg 1969: 360). It was argued by Darwin in the *Origin of Species* that the similarities of the bones in the hand of a man, the wing of a bat, the fin of a porpoise and the leg of a horse are due to descent with slowly acting successive modifications (Chapter 14; 1998: 361). Berg countered that in many groups of plants and animals the general trend of the evolutionary process is due to convergence, which affects both the external and essential characters of organisms. Since organic development is determined by laws, those organs are formed which must be produced according to the constitution of the organism and external effects, and are not random forms to be selected. Therefore, similarity of characters may be due to a common origin, but it may also be the result of a certain uniformity in the laws of nature (Berg 1969: 360-361).

As we noted in an earlier chapter, the homology between structures such as the arm, fore-leg, wing, and fin among various vertebrate classes was already understood by Aristotle. The term homology was introduced by Richard Owen in the nineteenth century, although the concept had been in use since the sixteenth century to indicate the corresponding parts of animals with a common body plan. Homology is therefore a pre-Darwinian concept, associated with the

Platonic notion of archetypes. However, Erasmus Darwin argued that the similarities among tetrapods indicate their common origin, and it is in this sense that his grandson Charles drew homology into his theory as evidence of evolution (Swift 2002: 319). Nevertheless, the evolutionist view of homology as providing evidence of past evolution is problematic. For instance, the tetrapod limb which first appeared with the earliest amphibians is said to have evolved into such diverse structures as the bird's wing, the seals' flipper and the human arm, since they are all based on a common bone arrangement. However, in each of the tetrapod classes these bones have a distinctive arrangement and do not appear to be derived from a common underlying pattern. Moreover, in the fossil record there are no known gradations between these types of fore-limb to show their evolution from a common ancestor. Instead, 'the different animal groups, notably those with highly specialised limbs – such as pterosaurs, birds and bats for flying, and ichthyosaurs and cetaceans for swimming – appear abruptly, not progressively' (Swift 2002: 319, 321).

Based on his extensive field-work on the fossils of soft-bodied animals around the world, Simon Conway Morris has become the leading thinker on evolutionary convergence of our time. Before embarking on a wide-ranging survey of convergence in his *Life's Solution: Inevitable Humans in a Lonely Universe*, the British palaeontologist notes that the building blocks of life are limited in number (2003: 27). They are the nucleotide base pairs of DNA and RNA, containing genetic information and instructions; around 20 amino acids for building proteins; and the carbon-based sugars and fatty acids. From these relatively simple foundations all the vast diversity of the natural world arises. Conway Morris then adds that the notion of convergence provides a metaphor depicting how evolution navigates the combinatorial immensities of biological 'hyperspace' (2003: 127). The ostensibly humble beginnings of cosmic evolution, yet pregnant with potentialities, has been affirmed by Denis Alexander: 'The physical properties of the universe were defined in the very first few femtoseconds after the Big Bang, and the process of evolution depends utterly on that particular set of properties' (2008: 135). Thus in the organic realm, convergence entails 'the selection of very similar morphologies drawn from a universal stockpile of preformed potentialities which were available when those evolutionary events took place' (Davison 2000: 43). In other words, over billions of years the unfolding of possibilities in the cosmos has proceeded from the physical and biochemical properties embedded in the ontological fabric of the whole.

Preparing the way, as it were, for convergence among plants and animals is the dynamic of molecular convergence. The protein molecule myoglobin, which is used to store oxygen, has apparently evolved independently in cyanobacteria and mammals (Conway Morris 2003: 288). High concentrations of myoglobin are found in the muscles of diving and burrowing animals, with evidence of molecular convergence in terms of an increased content of the amino acid arginine. A number of animals and plants living in very cold regions have developed anti-freeze proteins, with evidence for convergence found in at least the insects involved. Two groups of fish, the Arctic cod and the Antarctic notothenioids, generate anti-freeze proteins that are effectively identical, despite having different genes for producing these proteins. Another example of molecular convergence is the enzyme lysozyme, which enables the digestion of tough plant material. The molecules of lysozyme have evolved convergently in such unrelated animals as cattle, certain Old World monkeys (e.g. the langur), and the enigmatic hoatzin bird of the Amazon forests (Conway Morris 2003: 288, 298).

It is rather ironic that the advent of global warming, which is at least partially due to the human addition of vast quantities of carbon dioxide to the atmosphere, has been beneficial to plants. Over roughly the past ten million years, until the advent of the industrial era, the levels of atmospheric carbon dioxide underwent a gradual decline, presenting a challenge to plants which require this gas for photosynthesis. In order to meet the environmental challenge (as well as increasing aridity and salinity) a number of plant species developed a new method, known as C_4 photosynthesis. Although biochemically highly complex, C_4 photosynthesis has evolved independently at least 31 times in the plant kingdom. This pertains notably to the grasses, which is highly significant in at least two respects. First, the development of extensive grasslands on most of the continents contributed much to mammalian evolution, especially of the herbivores (and thus also of the carnivores feeding on the herbivores). Second, grasses such as wheat, rice and maize have been staple foods for the bulk of humankind over thousands of years, and have thus played a major role in human survival (Conway Morris 2003: 292-294).

12.2 Convergence of internal characters

In the case of insects with its more than 30 orders, convergence affects all of the organs, Berg asserted (1969: 164-166). For instance, in lowly organised insects such as Neuroptera (lacewings and ant-lions) there is a convergence of various characters with higher groups such as Diptera (flies) and Lepidoptera (butterflies and moths). The similarity of vertebrates to invertebrate groups such as Annelida (segmented worms) is due to convergence, Berg adds, regardless whether they derive from one common stock or vertebrates having a polyphyletic origin. For example, there are structural resemblances in their urino-genital system, circulatory system, olfactory organs, and lateral line. Moreover, the parallelism between Dipnoi (such as lungfishes) and Amphibia (e.g. in their lungs, skull, brain, and pelvis) shows that organisms develop in conformity to inherent forces, which in the presence of certain conditions become embodied in definite forms (Berg 1969: 167-168, 172-175). This reference to inherent forces determining organic morphology evokes the Hellenic doctrine on the priority of formal causality, without denying the reality of efficient and material causation.

When comparing dinosaurs and birds we find a number of similarities, for example the existence of pneumatic bones even when the saurians did not fly; walking on the hind limbs, i.e. a bipedal motion; and an increase in the number of sacral vertebrae from three to ten, compared to living reptiles which only possess two or three. Also, the first digit in the foot of many dinosaurs is contraposed and reversed, as in birds; while in some saurians it is rudimentary or completely disappears, as in birds like the ostrich, plover, and auk. Therefore, regardless of the descent of dinosaurs and birds, their similarities in structure are due to convergence – that is to say, development in a determined direction (Berg 1969: 175-179, 185). In the case of flying reptiles one observes the resemblance of types such as pterosaurs to birds, manifested in both external and structural features, although these saurians are not viewed as ancestors of birds. Resemblances include the structure of the skull, the lower jaw, and the cervical vertebrae; the number of sacral vertebrae increasing from three to ten as in birds; and similarities in the pneumatic bones and the brain (Berg 1969: 189-191).

Numerous other structural similarities between animals of unrelated taxa are mentioned by Berg. In the case of crocodiles and birds there are an astonishing range of resemblances. These include a four-chambered heart, as well as the lungs, ribs, structure of the fore-limbs, nervous system, hearing organs, and digestive organs. Even the brain of crocodiles resembles birds more than those of any other reptiles (Berg 1969: 187-188). Pterosaurs and mammals have similarities in their skeleton, for example the femur and the humerus. It is noteworthy that the habits of mammals and pterosaurs are so different that their similarities cannot possess any adaptive significance. Comparing Theromorpha (a small group of extinct reptiles) and mammals we notice many similarities, but since mammals are not derived from Theromorpha, their resemblances are due to parallel development. The structural similarities between lemurs and apes also developed independently (Berg 1969: 192-196, 197-198). Further examples of convergence between unrelated groups are the following: the limbs and teeth of Equidae (the horse family) in North America and Litopterna (an order of extinct ungulates) on the Argentinian plains; Ichthyosauria (an extinct order of large marine reptiles) and dolphins, pertaining to the head, neck, fins, and so forth; and the diurnal birds of prey and owls display many points of resemblance in internal structure, e.g. the muscles of limbs and in the crop, although belonging to widely separated orders (Berg 1969: 200, 212-213).

Further examples of convergence in organs among unrelated animals are mentioned by Douglas Dewar. These are the tracheae that constitute the breathing organs of velvet worms, millipedes, centipedes, insects, spiders, scorpions and wood-lice; and similar types of nephridia in amphioxus and polychaete worms (2005: 39). The latter organs are the invertebrate equivalent of kidneys in vertebrates. Structural convergence among unrelated taxa occurs likewise among plants, as in the case of monocotyledons and dicotyledons, possessing one and two seed leaves respectively. These parallel, polyphyletic stems developed independently, with mutual similarities due to convergence (Berg 1969: 205).

The immense range of convergence in the organs of animals and plants sometimes illustrate the principle of phylogenetic acceleration, Berg notes. Thus the placenta (i.e. the organ connecting the embryo to its mother) was formed independently in Polyzoa (moss animals), *Peripatus*, certain insects and scorpions, certain marsupials, and all placental mammals. This cannot be due to common descent since monotremes, marsupials, and placental mammals are parallel branches that arose independently of one another (Berg 1969: 214-216). The emergence of a placenta is due to the retention of the embryo within the female reproductive tract, which is the technique of ovoviviparity. This method of reproduction is estimated to have evolved independently around 100 times among lizards and snakes, as well numerous times among frogs and fishes. Moreover, the Brazilian lizard *Mabuya heathi* converge in its reproduction on mammals by having a placenta, a minute egg comparable to a mammalian ovum, and a prolonged period of gestation. Some viviparous lizards, such as the European *Chalcides chalcides*, develop a placentome which is cast off when giving birth, similar to the mammalian afterbirth (Conway Morris 2003: 220-221).

The 70 species of the fascinating yet little-known velvet worm constitute the invertebrate phylum Onychopora, living in tropical and southern temperate zones of the world, including

South Africa and New Zealand (Cooke *et al* 2008: 587). With its combination of arthropod and annelid characters, the velvet worm represents one of the most remarkable instances of convergence in the animal kingdom. Incidentally, the genus *Peripatus* also nourishes its developing embryos with a kind of placenta, as noted by Lev Berg. *Peripatus* thereby combines features of three major taxa: the phyla Annelida and Arthropoda, and the placental Mammalia (Davison 2000: 42).

In view of the foregoing facts it is not surprising that sensory convergence is also widespread. The eye has evolved at least 20 times independently, including at least 15 lineages of photo-receptors with a distinct lens (Conway Morris 2003: 164). For example, the eye of vertebrates and of cuttlefish (related to squid) are structurally very similar, each possessing a lens and an iris with comparable performance. However, these eyes are not actually homologous, since they arose independently in different phyla (i.e. chordates and molluscs) which have completely different body plans and phylotypic stages (Swift 2002: 320). There is also a structural similarity in the optic ganglia of insects and vertebrates. According to the entomologist A. Zawarzin, this phenomenon is not only a case of convergence but a principle of structure common to the entire animal world (Berg 1969: 221-222).

Another optical convergence between vertebrates and invertebrates is the phenomenon of organisms with pairs of eyes for simultaneous vision in air and water. It occurs in the Central American four-eyed fishes, namely the fresh-water *Anableps* and the marine *Dialommus* (belonging to different orders), and in whirligig beetles (*Gyrinus*), where it serves precisely the same purpose (Berg 1969: 218-219, 307). Interestingly, whirligig beetles count among the roughly 30 000 species of aquatic insects (Cooke et al 2008: 562), all said to have evolved from terrestrial ancestors. However, such a descent would have required drastic changes in anatomy and physiology pertaining to the modes of locomotion, feeding, and respiration, which have not been satisfactorily explained (Dewar 2005: 251-252). Optical convergence also occurs between chameleon lizards and sand-lance fishes, in which the camera-eye has been modified with the replacement of the lens by the cornea. The latter is fitted with muscles to enable focusing, which enables the chameleon and the sand-lance to rapidly strike at their prey, with their tongue and whole body respectively (Conway Morris 2003: 164).

It is noteworthy that the sense of sight is not restricted to animals. Photosensory devices such as eye-spots are found in a number of single-celled organisms, for example the eukaryotes

Chlamydomonas and *Volvox*. Moreover, the visual protein rhodopsin employed by these eye-spots appear to be convergent on the equivalent protein found in human and other animal eyes. Also relevant is the complex optical system of the single-cellular organisms called dinoflagellates. In spite of being less than one tenth of a millimetre in length, their optical apparatus is strikingly convergent on the animal eye (Conway Morris 2003: 165). In view of all this evidence, the evolution of eyes is viewed as virtually inevitable by Conway Morris: ‘Given that key molecules required for vision, such as rhodopsin and the crystallin proteins, evolved in single-celled organisms this suggests that given time and the adaptive value of light discrimination then the evolution of the eye seems to be a near inevitability’ (2003: 173).

Various instances of ‘seeing’ without eyes are found among some mammal and bird species. For example, the star-nosed mole (*Condylura cristata*) in North America uses the extremely sensitive, fleshy tentacles on its nose to ‘see’ while burrowing in soil or swimming in water, even though it is almost blind (Conway Morris 2003: 175, 177). Some animals have developed echolocation to ‘see’ in the dark, the most famous being bats. Almost incredibly, certain moth species favoured by bats produce ultrasonic clicks, apparently to jam the bat’s sonar. Echolocation is also used by dolphins, as well as by birds inhabiting deep, dark caves, such as South American oilbirds and Asian swiftlets. As Conway Morris aptly remarks, with their faculty of echolocation animals such as bats, dolphins, and some birds inhabit a sensory world that is completely unknown to humans (2003: 181-182).

Regarding the sense of smell, or olfaction, we find evidence of convergence between vertebrates and insects, in spite of differences in their relevant anatomy (i.e. nose and antennae) and molecular genetics (i.e. different proteins to bind odours). For instance, the glomeruli of insects have precise counterparts in the olfactory bulbs of vertebrates, with their olfactory sense operating on the same principles. And since the ancestors of vertebrates and insects, namely the amphioxus and aquatic crustaceans respectively, do not possess glomeruli, it has to be concluded that their practically identical olfaction arose independently (Conway Morris 2003: 179-180). It should, however, be kept in mind that the postulated descent of vertebrates from invertebrate chordates such as amphioxus is disputed, as we noted earlier.

As far as the hearing sense is concerned, it appears that the ear with a tympanic membrane has evolved independently several times among the tetrapod (four-legged) vertebrates. As is the case with the other organs of sense, we also find hearing convergence between vertebrates and insects. For example, in the mosquito a complex antenna serves as the equivalent of an ear. It includes an organ containing numerous nerve cells sensitive to sounds, so that the hearing of mosquitoes is remarkably similar to that of mammals. A tympanal structure analogous to our eardrum is found among insects such as moths, grasshoppers, and crickets. Even the process of transduction, i.e. the conversion of a mechanical force such as sound into an electric signal, is similar in vertebrates and insects (Conway Morris 2003: 190-193).

Another fascinating biophenomenon is the electrical generation found in various species of fish. Freshwater species include the electric eel (*Electrophorus*) from South America, and the electric catfish (*Malapterurus*) and elephant-nose fish (*Campylomormyrus*) from Africa. The former two species are capable of generating an electric current of several hundred volts for stunning prey and deterring predators. In its turn the elephant-nose discharges a weak electric current around its body, which is used for navigation at night or in murky waters (Cooke *et al* 2008: 473, 485). This faculty of electro-generation has evolved independently at least six times among fish of various genera, through modification of muscle cells. It is also used for communication, with each species producing a highly specific electric signal which enables the fish to 'see' or 'hear' in opaque water. Interestingly, in the African *Mormyrus* species the fish have an enormous brain in relation to their body size, comparable to the human brain. This presumably facilitates sophisticated neurological processing in the dark, electrically charged water in which these fish live (Conway Morris 2003: 183, 185, 187, 194-195).

There is also a physiological parallelism between animals and plants, which is not unexpected given the similar physical and biochemical constraints in their evolution. For example, in certain insectivorous plants a ferment similar to pepsin is secreted for the digestion of animal food. Also, the chitin of animals such as annelids, molluscs, and arthropods is very similar in its chemical structure to plant cellulose. Another case of convergence due to chemical action is chlorophyll and haemoglobin molecules, which both contain a nucleus approximating their pigments to the dye-stuffs of the indigo group (Berg 1969: 223-225). The most well-known fauna of the Cambrian period are the trilobites, which roamed the world's oceans for over 270 millions years until they became extinct at the end of the Permian. These highly successful arthropods had an exoskeleton which was biochemically similar to the cellulose used by plants (Swift 2002: 261; Wikipedia: Trilobite). The phenomenon of parallelism confirms that the actions of chemical substances (affecting both morphology and physiology) are subject to certain laws, and not due to infinite variations (Berg 1969: 225).

The points of similarity in the organs of groups of organisms are in some cases due to common descent, i.e. genetically, and in others due to convergence. As argued by Lev Berg, ‘Both convergence and homology (similarity due to relationship) are governed by laws. Therefore, if evolution is nomogenesis, chance and natural selection evidently play no part in the origin of new organic forms’ (1969: 226). The embryological evidence appears to support this distinction between homology and phylogeny, against the Darwinian view that the similarities in homologous organs among unrelated species are due to a common ancestor. In the latter conception homologous structures arise due to comparable embryological tissues as well as similar developmental processes. However, it has been discovered that certain apparently homologous adult structures do not arise from comparable embryological sources, as was admitted by the eminent embryologist Gavin de Beer in his *Homology: an unsolved problem* (1971). And if similar morphological structures developed from different embryonic sources, as the evidence indicates, then homology can no longer be adduced as support for evolution (that is to say, in the Darwinian sense). In fact, ‘the inconsistency between morphological homology and supposed phylogenetic relationships has become a further challenge to the theory of evolution’ (Swift 2002: 330-331, 333).

That evolution is not always ‘progressive’ is evident from the phenomenon called phylogenetic atavism, which is the manifestation in adult organisms of certain features possessed by their ancestors. In other words, atavism is the reverse of acceleration. This implies that evolution is not irreversible as some scientists have claimed, since a recessive character may again be manifested when favourable conditions arise. It was demonstrated by Gregor Mendel that recessive characters not infrequently appear in organisms in old age, which means that the tendency of characters to become dominant weakens with age. Sometimes the characters of the young organism reappear in the adult, for example salmon coloration and ammonite shell-forms (Berg 1969: 226-228). A remarkable case is the fish *Myoxocephalus quadricornis* that lived in the Baltic Sea, with four bony ‘horns’ on its head when the sea was salty (the Yoldian epoch). It was ‘transformed’ into the form *M. relictus* without horns when the sea became a fresh-water lake (the Ancylus epoch), and reverted to a form with four horns (living to this day) when the sea again turned salty (the Littorina epoch). Such atavism, or the reversion of characters, is rare and exceptional, but parallelism and convergence are constantly present (Berg 1969: 229-230, 232-233). The rate of evolution of various characters is not uniform, and therefore some organisms combine features of very high organisation with very low ones, such as sharks and seed-ferns (Pteridospermae). Yet, Berg insists, even the reversion of characters occurs in compliance with definite laws, and not due to chance (1969: 233).

12.3 Convergence of external characters

There is no fundamental difference between the convergence of external and internal characters, Berg contends (1969: 235-236). After studying parallel variations in diverse cultivated plants, the botanist Nikolai Vavilov stated the Law of Homologous Series of Variations: 'Species and genera more or less nearly related to each other are characterised by similar series of variation with such a regularity that, knowing a succession of varieties in one genus and species, one can forecast the existence of similar forms and even of similar genotypical differences in other genera and species' (quoted in Berg 1969: 236). Such parallel variations are found within a species, a genus, a family, or even further afield. Examples thereof are found in: (i) species of wheat (genus *Triticum*) and barley (genus *Hordeum*); (ii) different genera of the same family, e.g. polymorphism in the rye *Secale cereale*; and (iii) distant families, even orders and classes, both in wild and cultivated forms. These include the phenomena of albinism, gigantism, nanism, and fasciation (Berg 1969: 237-240).

Darwin recognised many cases of 'analogous or parallel variations' in his works. However, he ascribed their origin to either unknown causes having acted on organic beings with a similar constitution, or to the reappearance of characters possessed by a remote progenitor. As remarked by Berg, the first explanation signifies nothing more than the unfolding of certain latent factors; that is to say, natural selection played no part (1969: 240-243). Against Darwin's notion of infinite variability, Berg argues that variations in the same direction will always ensue under definite conditions. In other words, the inherited tendency of organisms to vary in a like manner, thereby causing convergence, is not exceptional as Darwin thought, but rather a fundamental law of evolution in the organic world (Berg 1969: 244).

The lawfulness of evolution is the reason why we observe many parallel forms in fishes, amphibians, and reptiles. Among the latter count the Old World Agamidae and the New World Iguanidae (Berg 1969: 244-5). Among mammals, in both the primate tarsiers (genus *Tarsius*) and the marsupial colocolo (*Dromiciops*) the second and third toes have almost identical claws, which are used as a toilet comb (Dewar 2005: 39). Interestingly, it has been confirmed by DNA studies that the colocolo (found in Argentina and Chile) is more closely related to

Australian than other South American marsupials, thereby reinforcing the theory that marsupials migrated from South America to Australia via Antarctica between 100 and 65 million years ago when these continents were joined together as the Gondwana landmass (Cooke *et al* 2008: 70). Parallelism is also found in heterogenous variations, i.e. mutations, for example in insects and plants. This holds true even in the shape of anomalies, such as the atavism in the heath family Ericaceae (Berg 1969: 253-255, 257-258).

A remarkable case of evolutionary convergence in action is New Zealand, which has been isolated in the Pacific Ocean for at least 85 million years. Prior to the arrival by boat of Polynesians around AD 1000, these islands were too remote to be colonised by terrestrial mammals, except for bats. However, several species of birds and even insects have evolved converging on mammals. For example, the giant wingless crickets known as wetas (*Deinacrida heteracantha*) are related to locusts, but converge on mice and rats in terms of biomass, nocturnal foraging, use of diurnal shelters, polygamy, and even their droppings. An endemic bat species has become partially terrestrial and walks on the ground with its wings folded (Conway Morris 2003: 218). Most remarkable of all is perhaps the kiwi (*Apteryx*), the national emblem of New Zealand. This flightless, nocturnal bird has feathers that are fur-like (which facilitates living in burrows), its nostrils are located at the tip of the beak rather than the base (thus improving its sense of smell when foraging at night), and the feathers around its mouth are whisker-like. Even more convergent on mammals is the kiwi's protracted incubation period, even though it is egg-laying. For reasons of both anatomy and behaviour, the kiwi has been referred to as an honorary mammal (Conway Morris 2003: 219-220).

The most well-known instance of convergent evolution among entire organisms is probably the equivalence between a large number of placental mammals and their marsupial counterparts, filling similar ecological niches. Marsupials (also known as pouched mammals) comprise seven orders, of which three are found in the Americas and four in Australasia. The fossil record indicates that marsupials and placental mammals diverged more than 100 million years ago (Cooke *et al* 2008: 68). Examples of placental-marsupial equivalence include the following (Bergman 2009: 143): the grey wolf (*Canis*) and the extinct Tasmanian tiger (*Thylacinus*); the ocelot (*Leopardus*) and spotted-tail quoll (*Dasyurus*); the giant anteater (*Myrmecophaga*) and numbat (*Myrmecobius*); the flying squirrel (*Glaucomys*) and glider (*Petaurus*); the groundhog (*Marmota*) and wombat (*Vombatus*); the house mouse (*Mus*) and mulgara (*Dasycercus*); and the golden mole (*Amblysomus*) and marsupial mole (*Notoryctes*), both being sightless and insectivorous. Berg also mentions the koala (*Phascolarctos*) and the flying lemur (*Galeopithecus*) as the marsupial equivalents of the bear (*Ursus*) and the flying squirrel (*Pteromys*), respectively (1969: 303).

Another interesting case of marsupial-placental convergence is the striped possum of Australia and New Guinea and the aye-aye of Madagascar, which are both arboreal insectivores. Both of these unrelated species have an elongated finger that enables them to extract wood-burrowing grubs (Cooke *et al* 2008: 68). There is also a striking resemblance between the placental and marsupial sabre-toothed cats, with their dagger-like teeth which developed independently (Alexander 2008: 327). Their similarities extend even to the large flange on the lower jaw, which according to Otto Schindewolf was designed to guide and protect the upper canines (Davison 2006: 3). To this impressive list of convergence we would add the Tasmanian devil (*Sarcophilus harrisii*) as the marsupial equivalent of the African honey badger (or ratel, *Mellivora capensis*), in both morphology and behaviour.

Among mammals, only bears and humans have a bipedal gait (apes do not qualify, since they have to use their arms for support). It is therefore not surprising to learn that in both bears and humans the first toe is lengthened. Among rodents and insectivores, convergence is found in mice and shrews, and porcupines and hedgehogs, respectively (Berg 1969: 301, 303). The aquatic mammalian orders Cetacea (whales and dolphins) and Sirenia (manatees and dugongs) are anatomically far apart but nonetheless possess various structural similarities. They all display a fusiform body, an absence of posterior extremities, a transformation of fore-limbs into flippers, the presence of a caudal fin, an elongation of the lungs and its transformation into a kind of hydrostatic organ, and the disappearance of body hair and external ears. The transformation of hind-limbs into organs for jumping occurs in rodents, insectivores, and marsupials. In the South and Central American forests mammals of different orders are found with prehensile tails. These include a number of monkeys, the kinkajou (allied to bears), tree-porcupines, anteaters, and various marsupials (Berg 1969: 303-305).

In the order Insectivora there are numerous cases of convergence among species that are not closely related, living in similar habitats on different continents. For example, the European desman and the Madagascar tenrec are both aquatic, with a waterproof coat, streamlined body, partially webbed feet, a long tail acting as a rudder, and specialised mechanisms for breathing and detecting prey underwater. European moles and African golden moles are burrowers with cylindrical bodies, powerful short limbs, large digging claws, and tiny eyes hidden by fur or skin. European hedgehogs and African tenrecs both have a thick coat of spines, curling up into a spiky ball when they are threatened. Both Cuban solenodons and African tenrecs have apparently developed echolocation for the location of their prey (Cooke *et al* 2008: 84). There are also cases of convergent evolution due to similar lifestyle among rodents, for example tree squirrels and scaly-tailed squirrels which are only distantly related, but members of both families possess a membrane for gliding. Another example is the North American prairie dog and the South American degu, which both live in large colonies in extensive systems of burrows and communicate through a range of vocalisations (Cooke *et al* 2008: 218, 238).

Among burrowing mammals, also known as fossorial species, evolutionary convergence occurs among three orders with 11 separate families and at least 150 genera, spread over all the continents except Antarctica. They converge in anatomy, physiology, behaviour, and even aspects of genetics. In addition, some of the mole-rats (e.g. *Heterocephalus* and *Bathyergus*) have evolved a social system with one reproductive female, while the rest are divided into castes, including workers. This colonial structure in which the breeding female, or queen, is protected from danger at all costs is found not only among mammals, but also converges in ants, bees, wasps, termites and certain beetles (Conway Morris 2003: 139-143).

In the case of birds we observe convergence between the penguins of the southern hemisphere and the auks of the northern hemisphere. Both forms live in a cool oceanic environment and have wings modified into flippers for underwater swimming. However, they do not share a recent common ancestor, having been separated by the warm tropical waters for many millennia, and their similarities are therefore due to convergent evolution (Cooke *et al* 2008: 26). Convergence between reptiles and amphibians is displayed by the subterranean lizards of the suborder Amphisbaenia and the amphibian order Gymnophiona, known as Caecilians (Cooke *et al* 2008: 370, 427). Both groups are built for burrowing, possessing a rudimentary tail, subcutaneous eyes, a soft skin deprived of eyes, and a compact skull. Both also have a peristaltic motion of the body, as is found in earthworms (Berg 1969: 306). Regarding optical convergence, telescopic eyes with a supplementary retina are found in some deep-sea fishes, various crustaceans, and insects such as dragon-flies. The contrivance of claws for capturing prey is found in different invertebrate classes such as scorpions (Arachnida), crayfish (Crustacea), and the ambush bugs of the subfamily Phymatinae (Berg 1969: 307, 310).

Among plants convergence is found in the similar morphology of American cactuses, the African family Euphorbiaceae (spurges) and the South African succulent genus *Stapelia*, due to adaptation to definite external conditions (Berg 1969: 311). These plants, known collectively as xerophytes, live in conditions of extreme aridity and display a whole range of similarities. Conway Morris illustrates the case by means of two unrelated desert plants, a Mexican cactus (*Peniocereus striatus*) and a Kenyan spurge (*Euphorbia cryptospinosa*). A cross-section of their stems shows remarkable similarity in structure, such as flat ribs and intervening recesses for the preservation of water. Their similarity extends to the interior of the stems, with water-storing cells and a starch-rich central pith that provides food for the plant. Both species also possess a reddish pigment which provides a moribund appearance to the plant, presumably making it unattractive to herbivores (Conway Morris 2003: 134-135).

Structural convergence due to similar living conditions also pertains to the Mediterranean-style floras in parts of the world as far from the Mediterranean itself as Chile, South Africa and West Australia. It extends to plant-animal interactions such as the dispersal of seed by ants, of which convergence has been shown between Australian and South African species. As a matter of fact, among plants from the tundra to the tropics convergence is pervasive, for example in leaf structure (Conway Morris 2003: 135, 365). In the case of aquatic plants, the dicotyledons of the riverweed family Podostemaceae living in rapidly-moving water are similar in both external form and internal structure to algae, liverworts, mosses and lichens. As adaptations to aquatic life, the leaves of plants of various families are deeply dissected and become thread-like in shape, while some species have both submerged dissected and floating whole leaves (Berg 1969: 312-313).

From the above-mentioned examples it is indisputable that convergence due to adaptation to a similar mode of life is ubiquitous. Berg concludes that this phenomenon is subject to certain laws and is therefore unaffected by natural selection (1969: 313). In the meantime the science of genetics has thrown further light on this aspect of convergence, as is shown by David Swift in his *Evolution under the microscope*. For example, very different animal groups such as bony fish, sharks, ichthyosaurs (extinct marine reptiles) and dolphins all have or had a streamlined body well-suited to their aquatic mode of life. The Neo-Darwinian explanation for this phenomenon is that numerous variations arose through random mutations in these groups, which were selected until the most suitable body shape emerged. However, the biochemical evidence mitigates against the production of new genetic material during the evolutionary process, indicating instead that species have descended by segregation and selection from a primordial gene pool. That is to say, the unrelated aquatic fauna acquired their similar streamlined forms not through mutation, but because their primordial ancestors already possessed appropriate genes (Swift 2002: 250, 252).

12.4 Convergence of psychical phenomena

According to Lev Berg, instincts have not been derived from intelligence, nor vice versa, but both have presumably been independently derived from reflexes, and have then developed along parallel lines (1969: 260). However, Berg appears to be following the dictates of scientific materialism with this reasoning, since intelligence cannot be reduced to an epiphenomenon of the cerebral system. The Russian biologist stands on firmer ground when he affirms that the development of languages follow phonetic laws. For instance, each group of Indo-European languages developed new forms parallel to each other, which accounts for their common structural features. An example thereof is that in many Indo-European languages the past tense is formed by combining a participle with an auxiliary verb (Berg 1969: 260). As far as linguistic convergence is concerned, experiments with dolphins have shown that they are able to master both syntax and semantics. According to Lori Marino, species such as dolphins, chimpanzees, and perhaps African Grey parrots have converged to a level of cognitive complexity that is ready for articulate speech. It has therefore been asserted by Conway Morris that language is an evolutionary inevitability (2003: 252-253). Or, as suggested by the eminent linguist Noam Chomsky, it appears that the brain has a kind of grammatical software programmed into it (Thompson 1984: 43).

Continuing his discussion of psychic convergence, Berg remarks on the similar manifestations of spiritual and material culture among various human races. This is attributed to similar elementary ideas (German *Elementargedanken*) found in numerous peoples (Berg 1969: 260-261). Thus the same types of implements and weapons, such as bows and arrows, fire-making, wrought stones, fish-hooks and nets, have been independently invented all over the world. These elementary ideas develop further under the influence of a particular environment, analogous to the development of organisms. The same argument also applies to systems of numeration such as binary, quinary, decimal, duodecimal, and vigesimal (i.e. based on the numbers 2, 5, 10, 12 and 20, respectively). Another remarkable case of psychic convergence is the independent discovery of the infinitesimal calculus by Newton in England and Leibniz while living in Paris (Berg 1969: 261-262).

Among non-human mammals the anthropoid apes and dolphins are generally viewed as the most intelligent species. In fact, some dolphin species have a significantly larger brain than the chimpanzee, gorilla and orang-utan. According to the research of Lori Marino, dolphins were the biggest-brained organisms on the Earth until approximately 1.5 million years ago, when they were overtaken by the hominid *Homo erectus* (Conway Morris 2003: 247). The large brain size of dolphins is related to their sophisticated social organisations and its concomitant advanced vocalisations, Conway Morris suggests. Recent studies have shown that dolphins have a more advanced social structure than chimpanzees, genetically our closest animal relative; and they possess complex and varied vocalisations, some of which converge on those of porpoises (Conway Morris 2003: 249-250). It appears that dolphin intelligence is more convergent on humans than that of apes, as is evident from their complex social life, their sophisticated communication, their ability to learn and mimic, and also their playfulness and self-recognition. Despite the cetacean and primate lineages having diverged around 65-70 million years ago, and although strikingly different in neuro-anatomy, dolphins and the higher primates thus converge in cognitive ability (Conway Morris 2003: 257-258).

Another type of psychic convergence is the resemblance in social organisation between two of the largest mammals, namely sperm whales and elephants. In both species the females and the young form social units, with long-distance vocalisations and intense socialisation. The males are solitary and wide-ranging, returning to the social units only when they are sexually mature and strong enough to compete in mating contests. Convergence between sperm whales and elephants entails social complexity, communal care of the young, intelligence, memory and even longevity (Conway Morris 2003: 250). Convergence also pertains to music – for example, the songs of male humpback whales are constructed according to the musical laws followed by human composers. This led the biologist Patricia Gray to relate whale and bird song to the Platonic theory of music: ‘The similarities among human music, bird song, and whale song tempt one to speculate that the Platonist alternative may exist – that there is a universal music awaiting discovery’ (quoted in Conway Morris 2003: 421). Once again we encounter the notion of organic lawfulness in the Platonic sense of the word.

The concurrence of psychical convergence with social organisation is displayed on a grand scale among certain invertebrate groups, for example termites, ants, bees, and wasps. Such convergence occurs in considerable detail among different orders, for instance South

American ants and African termites with their fungus nurseries and differentiation between workers and soldiers (Berg 1969: 311). An astonishing case of convergence is that of the leaf-cutting ants in South and Central America (genera *Acromyrmex* and *Atta*), which have invented agriculture independently of humans. The farming activities of these ants are centred around the harvesting of leaves for the fungus gardens in the ant nest. Further farming tasks for the ants include weeding, pruning, cropping, and even the use of herbicides to protect their fungus gardens against pests. These industrious leaf-cutters form colonies of several million ants, displaying highly organised societies. The latter is also the case with the fearsome army ants in South America, especially the genus *Dorylus* of which a single colony may contain 20 million workers (Conway Morris 2003: 198-201). Another convergence between ants and humans is found in the slave-making ant (genus *Polyergus*), which raids the nests of closely related species to capture pupae, which are then raised in its own nest to become its workers (Cooke *et al* 2008: 578). Apparently, even human vices are paralleled among invertebrates.

Noting that the use of tools have emerged independently a number of times in the animal kingdom, Conway Morris contends that technology is inherent in evolution, as is the case with intelligence. Tools, after all, epitomise intelligence and purpose. The use of tools by various birds species is well known, but none more is more impressive than the New Caledonian crows, which have a more sophisticated tool culture than chimpanzees (Conway Morris 2003: 261). Once capability and motivation are combined, Conway Morris continues, tool use becomes inevitable. This phenomenon also occurs among some New World monkeys (for example the capuchin monkey and the golden lion tamarin) and even a species of parasitic wasp. That tool use is not a recent invention is suggested by the fossils of the bipedal ape *Oreopithecus*, which had a hand with a precision grip and lived in Tuscany between 7 and 3 million years ago (Conway Morris 2003: 262-264, 269-270).

12.5 Convergence and evolution

Evolutionary convergence is related to the phenomenon of equipotentiality, which has been defined as follows by the herpetologist Nick Arnold: ‘Different lineages of organisms often evolve a number of similar traits independently, but the order in which these are assembled may often be different, even in ecological analogues, especially if the taxa concerned are not closely related... This [is the] phenomenon of equipotentiality, where more or less the same overall condition is reached by different routes’ (quoted in Conway Morris 2003: 145). Therefore, evolution may not be inevitable, but it is highly predictable. It is also recognised that evolution shows reversals instead of a linear, irreversible progression, but nonetheless the various biological properties still arise (Conway Morris 2003: 145).

Although accepting the Neo-Darwinian notion of random mutation as providing the raw material upon which natural selection acts, the biochemist Denis Alexander concurs on the importance of constraints and convergence in the evolutionary process. In the words of Alexander: ‘So the rolling of the genetic dice in evolution is a wonderful way of generating both novelty and diversity, but at the same time it appears to be restrained by necessity to a limited number of living entities. If we live in a universe with this kind of physics and chemistry, and on a planet with these particular properties, then what we see is what we are likely to get... only a relatively tiny number of genomes will generate organisms that can flourish in the different ecological niches on planet earth, and the evolutionary process keeps “finding” these again and again... Evolutionary history on this planet displays overall increased complexity, genomic constraint and convergence’ (2008: 327, 330).

Conway Morris concludes that convergence confirms the reality of organic evolution. Despite emphasising the priority of adaptation in the evolutionary process (2003: 301-302), the English thinker approaches Hellenic metaphysics with the following statement: ‘The organic world is a plenitude and a marvel, but it still has a rational structure. Simplification will arise in its own adaptive circumstances, but so, too, will complexity’ (2003: 303). In referring to the plenitude of the organic world, Conway Morris evokes Plato and the chain of being; in his mention of marvel, he reminds us of Aristotle who declared in the *Metaphysics* that all philosophy began in wonder; and in affirming the rational structure of the world, he recalls the numerical cosmology of Pythagoras as well as the Neoplatonic doctrine that the cosmos is grounded in the divine Logos, sustaining the world through the reason-principles (*logoi*) that indwell all things.

13: Conclusion

Before time began, there was eternity. Before the many came into being, there was the One which in its essence is eternally beyond being and non-being. Simultaneously, the One is the Principle of all Manifestation, albeit indirectly. According to the Hellenic metaphysical tradition that we have surveyed (and especially in its Neoplatonic culmination), the One produces Intellect (*nous*, or Spirit) out of the abundance of its goodness, in order to make Manifestation possible. In its turn Intellect produces Soul (*psychē*) as the means for interacting with Matter, thereby giving rise to the cosmos. The physical cosmos arises out of pre-cosmic chaos through the activity of the World-soul, which becomes refracted into myriads of individual souls – namely, those of the celestial beings (gods/angels), humans, animals, and plants.

The active dimension of Intellect is the Logos, through which the One establishes the universe. As the cosmic lawgiver, the Logos regulates the conflict between opposites that characterises the world (as taught by Heraclitus). The Logos contains the totality of the *logoi*, or reason-principles, through which the Intellect indwells the realm of Manifestation, and on account of which the physical world possesses both being and intelligibility. The creative activity of the Logos (called the Demiurge by Plato and the Prime Mover by Aristotle) entails fashioning the cosmos according to numbers and geometrical figures. Accordingly, as explained by the Pythagoreans, the cosmos arises in the sequence of numbers, planes, surfaces, and solids – that is to say, a directed progression from non-dimensional numbers through one-dimensional lines and two-dimensional planes into three-dimensional bodies.

All solid bodies (including living beings) come to be through the interaction among a set of causes, of which four are enumerated by Aristotle: (i) the formal cause that provides a pattern (*paradeigma*) or structure to a thing; (ii) the material cause as the particular kind(s) of matter a thing is composed of; (iii) the efficient cause that applies the form (*eidos*) to the matter (*hylē*); and (iv) the final cause as the end or purpose (*telos*) for the sake of which a thing comes to be. In the case of living beings, various levels of soul are found that determine its nature, Aristotle taught. Thus plants possess a nutritive or vegetative soul, which enables nutrition, growth and reproduction; animals possess the foregoing as well as a sensitive soul, which enables sense-perception, memory and imagination; and humans possess the foregoing as well as a rational soul, which enables reasoning (*dianoia*) and thought (*noēsis*). The rational soul is moreover the seat of immortality, inasmuch as it chooses to orient itself upwards to the realm of Intellect, or Spirit, instead of immersing itself in the material realm.

Since organic form (*morphē*) is numerical and geometrical in its foundation, it follows that any autonomic transformation thereof has to comply with natural laws (*nomoi*) which are mathematical in nature. We have presented the uniquely insightful work of D'Arcy Thompson on the transformation of an impressive variety of organic forms to substantiate this argument. An organic form can therefore only be transformed into another organic form in accordance with these laws, so that the process is called nomogenesis, or evolution according to natural law, as Lev Berg has persuasively argued. We contend that nomogenesis pertains eminently to macro-evolution, which entails the generation of morphological novelty. This requires the production of new genetic material, thereby giving rise to forms that are substantially different from their predecessors. In this way complex structures, such as the eye or the feather, arise by means of a macro-mutational jump, instead of the gradual accumulation of minute variations as the modern evolutionary theory postulates. This macro-evolutionary process furthermore accounts for the arising of new phyla, classes, orders, families, and probably also genera, of plants and animals. Metaphysical speaking, macro-evolution thus fulfils the requirement of formal and final causality, against the rejection thereof in favour of mechanism and materialism by exponents of the modern scientific paradigm.

We have suggested that a clear distinction has to be made between macro-evolution and micro-evolution, since the former is not merely the temporal extension of the latter and driven by the same mechanisms of random mutation and natural selection, as is averred in Darwinism. Micro-evolution is the process whereby variations arise within a species, and probably also species within a genus. These entail minor morphological changes, thus conforming to Aristotle's explanation of the essential differences between one species and another as mainly due to differences of 'excess' and 'defect' (*History of Animals* I, 1). That is to say, species of the same genus differ mainly in relative magnitude and not in essential characters, which enables their participation in the same genus (Thompson 1992: 273-274). Pertinent examples of this phenomenon among vertebrates are the genera *Panthera* (big cats), *Canis* (wolves/jackals), *Ursus* (bears), *Equus* (horse/zebra), *Cervus* (deer), *Cercopithecus* (monkeys), *Aquila* (eagles), *Phalacrocorax* (cormorants), *Crocodylus* (crocodiles), *Varanus* (monitors), *Rana* (frogs) and *Acipenser* (sturgeon). In all these cases the species comprising the particular genus differ mainly in relative magnitude, as well as accidental characters such as coloration, and could therefore have become differentiated by means of micro-evolution.

It has been established by scientists that for micro-evolution to occur, no new genetic material is required. Instead, the separation and recombination of existing genes are sufficient to produce such minor changes, namely of bodily ‘excess’ or ‘defect’. In other words, micro-evolution entails genetic reshuffling and not genetic novelty as in the case of macro-evolution. The Darwinian mechanisms of random variation and natural selection are therefore sufficient, empirically speaking, for the production of new varieties and ultimately new species. A further difference is that micro-evolution takes place gradually over numerous successive generations, whereas macro-evolution occurs relatively suddenly. The fossil record indeed indicates that it is possible for a species and even a genus to evolve out of an existing one through gradual transformation, but there is no evidence that a new family has ever arisen in this way (Dewar 2005: 262-263). That is to say, micro-evolution can account for the arising of variations within a species, species within a genus, and possibly genera within a family, but not for any of the taxa from the level of families upwards.

We have shown by means of numerous examples from the organic realm that the macro-evolutionary process is characterised by lawfulness, direction, and convergence. Actually, convergence is interlinked with orthogenesis (or directed evolution), since the former results from development in a determined direction (Berg 1969: 157). Furthermore, modern biochemical knowledge demonstrates that biological macro-molecules cannot arise in a trial and error manner, as is the case with natural selection acting on the morphological level. This is confirmed by the palaeontological evidence, which indicates that new groups corresponding to new genetic material arise suddenly and not gradually (Swift 2002: 382-383). As a result of these biochemical and palaeontological discoveries, we may confidently state that Darwinism is no longer entitled to its monopoly as far as evolutionary theory is concerned.

The case for an alternative theory of evolution that recognises formal and final causality has in recent decades been powerfully argued by scientists such as Michael Denton and Jonathan Swift. In the words of Denton: ‘Four centuries after the scientific revolution apparently destroyed irretrievably man’s special place in the universe, banished Aristotle, and rendered teleological speculation obsolete, the relentless stream of discovery has turned dramatically in favour of teleology and design’ (1998: 389). Facts such as these led Simon Conway Morris to admit, ‘No wonder the arguments for design and intelligent planning have such a perennial appeal. Whether it be by navigation across the hyperdimensional vastness of protein space, the journey to a genetic code of almost eerie efficiency, or the more familiar examples of superb adaptation, life has an extraordinary propensity for its metaphorical hand to fit the glove... Its [i.e. life's] central paradox revolves around the fact that despite its fecundity and baroque richness life is also strongly constrained. The net result is a genuine creation, almost unimaginably rich and beautiful, but one also with an underlying structure in which, given enough time, the inevitable must happen' (2003: 19-20).

Metaphysically speaking, the appearance of a new organic form through mutation (as in macro-evolution) occurs in accordance with a morphological plan or structure which is the formal cause, while its survival through reproduction is the final cause (i.e. the purpose) of phylogenetic development. That is to say, the indwelling presence of the *logoi* ensures both formal and final causality in the organic realm. In this manner the physical reflects the metaphysical, from which it cannot be divorced without a radical loss of both ontological depth and epistemological scope.

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