HYLOZOISM AND HYLOMORPHISM: A LASTING LEGACY OF GREEK PHILOSOPHY

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ABSTRACT

Apparently philosophical reflection commenced when the awareness of diversity prompted the contemplation of an underlying unity. Thales found this principle of origination in water. Alongside elements such as water, air and fire as well as the *apeiron* (the infinite-unbounded) Greek philosophy successively explores different modes of explanation. Number, space and movement were succeeded by *hulè* and *morphè*, where these two terms at once captured a connection between the (material) world of becoming and the world of organic life. The combination of matter and form (life) gave rise to the two terms of our investigation: *hylozoism* and *hylomorphism*. These terms are also related to the act-potency scheme and they also presuppose the relation between primary matter and substantial form. In the thought of Aristotle one can also identify *energeia* with *entelecheia*. As soon as one of the two elements present in the two terms *hylozoism* and *hylomorphism* is elevated, a *monistic* perspective ensues, such as found in the opposition of mechanism and vitalism. These extremes sometimes surface in the shape of physicalism and the idea of an immaterial vital force. During and after the Renaissance, the idea of the mechanisation of the universe emerged, while vitalism continued its after-effect within biology, articularly seen in the legacy of *idealist morphology* (Ray and Linnaeus). The Aristotelian-Thomistic substance-concept appeared to have inherent problems. On the basis of experimental data Driesch revived vitalism (and Aristotle's view of an *entelechie*), but did not succeed in coming to terms with the physical law of non-decreasing entropy – he had to assign the ability to his *entelechie* to *suspend* physical laws in order to account for the increasing order found in growing living entities. However, his neo-vitalist followers further explored Von Bertalanffy's generalisation of the second main law of thermodynamics to *open systems*. Most recently the idea of a Workmaster (*Demiurge*) resurfaced in theories of *Intelligent Design*. These developments are explained by briefly referring to Michael Behe and Stephen Meyer. The historical lines discussed demonstrate how one-sided *ismic* orientations may make a positive contribution to the identification of unique and irreducible modes of explanation from which scholarly research could still benefit.

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FROM DIVERSITY TO AN UNDERLYING UNITY

In our everyday experience we are constantly facing a rich diversity of things, plants, animals, human beings and all kinds of social forms of life and cultural artefacts. It appears as if Greek philosophy emerged when this experience of diversity was related to the search for an *underlying unity*. A given diversity entails the idea that there are differences between diverse things. Since Thales chose *water* as this underlying and ultimate element he is accredited as the first Greek philosopher. Copleston holds that since "he assigns *water* as this element . . . he earns his place of the First Greek philosopher from the fact that he first conceives the notion of Unity in Difference . . . and, while holding fast to the idea of unity, endeavours to account for the evident diversity of the many" (Copleston 1985-I:23).

This formulation relates the one and the many to unity and multiplicity. The fundamental question is the following: do we have a unity-in-the-multiplicity or is there one or another element within the multiplicity that should be seen as its ultimate and underlying *unity*? The way in which Copleston phrases this issue suggests the second option. He states: "Philosophy naturally tries to understand the plurality that we experience, its existence and nature, and to understand in this connection means, for the philosopher, to discover an underlying unity or first principle" (Copleston 1985-II:23 – see Aristotle's discussion in his *Metaph*. 983b20 ff.; 988a18 ff.; Aristotle 2001:694 and 702).

The concern here is not on water as such, but on the fact that it serves to express an idea of **unity** (in diversity). Moreover, water, as the *origin* (*arché*) or *source* in the thought of Thales, is not designated by him as *substance*, since the term *substance* is first found in the thought of Ocellus Lukanus (a Pythagorean from the 5th century). Among the Fragments of Thales one finds a reflection *On the Principles* (PERI ARXWN). While referring to the first four [elements] he posits water as a *unique element* (*μόνον ντοιχεϊον*) (Diels & Kranz 1960:80; B. Angebliche Fragmente, Fragment 3). Furthermore, already Anaximander viewed the source (*arché*) of the elements to be something different from them, namely the *apeiron* (the infinite-unbounded) (Diels & Kranz B. Fr.1). It may seem as if Anaximander's alternative transcends the diversity of possible elements, but in the final analysis he merely reverts to an alternative understanding of the one and the many (Schrödinger 1956:78). The infinite was appreciated as being without an end in a numerical sense – one, another one, yet another one, and so on without an end, endlessly. And what is unlimited presupposes a spatial awareness of *boundaries* or *limits*.

EXPLORING ALTERNATIVE MODES OF EXPLANATION IN GREEK PHILOSOPHY

Early Greek philosophy commenced by wrestling with two distinct principles of explanation, namely *number* (the one and the many) and space (the assumed *static* nature of being). Parmenides argued against the reality of multiplicity and movement (Zeno) and he characterised being as *indivisible* (Parmenides B. Fragment 8:22; Diels &Kranz 1960:237).[1] It was Anaxagoras who turned the infinite, in the sense of an unbounded succession, inwards by highlighting the infinite divisibility of continuity. He holds the view that in what is large there is always a larger and in what is small there is always a smaller (Anaxagoras B. Fragments 3, 6 and 8; Diels & Kranz 1960:33,35,36). Copleston mentions Von Weizsäcker who says that it was Leucippus and Democritus "who made the question of the infinite divisibility of matter a basic question of philosophy" (see Copleston 1985-II:500).

MATTER AND FORM

Choosing a basic underlying element anticipates what Aristotle later on designated as □λη (*hulè*) which in turn was translated by Cicero as "materia" (Fischer 1996:24, note 5). Burnet mentions that Thales, Anaximines and Heraclitus ascribe the property of *being alive* to material things (Burnet 1908, Introduction, VIII, note 29). This view combines matter (ὕλη) and life (ζώειν = to live) and it is therefore also known as *hylozoism*. *Matter* and *life* represent two principles of origin which eventually, particularly in the thought of Plato and Aristotle, were captured as *matter* and *form*, united in the expression *hylomorphism*. However, both these terms are of a fairly recent origin. Cudworth for the first time employed the term *hylozoism* in 1678 (see Hager 1974:1237-1238), while the term *hylomorphism* came into use only by the beginning of the 20th century (see Oeing-Hanhoff 1974:1236-1237). In the third edition of his well-known *Wörterbuch der philsophischen Begriffe* (*Dictionary of Philosophical Concepts*), Eisler did not insert the concept *hylomorphism* – it is only found in the fourth edition (1927-I:641). Yet what these two terms mean is fully known in Greek philosophy.

The form is equated with soul, although Orphism does not accept any immortality of the human soul and also does not observe any intrinsic connection between soul and body because the soul, chained to the "wheel of births," originates in the luminous heavens and constantly appears in different bodies until it returns to its place of origin after the completion of the great astral year. Yet, the Dionysian matter motive, with its eternal flowing stream of life, demands that whatever takes on a form, must return to the

1 The neo-vitalist thinker, E.W. Sinnott, attributes this feature of indivisibility to form. He adheres to a dualistic view similar to what we will find later on in the thought of Haas. Sinnott believes that form does not inhere in units of matter (atoms, molecules and cells), because it is a "category of being very different from matter." Form "consists of *relations* among particles, of orderly pattern in them. It is a continuous entity and cannot be divided into pieces" (Sinnott 1963:199).

formless stream of life. Dooyeweerd states: "The basic conception of *hylozoism*, where the soul itself is viewed as a material stream of life, does not allow for such a duality. Only the eternally flowing origin, the one divine *physis* into which everything that has form must return in an eternal cycle, is immortal. Bodily form, on the contrary, is here merely a transitory phase of the stream of life" (Dooyeweerd 2012-I:76). On the same page he points out that the divine *physis* as conceived by the Milesians and Heraclitus is an amorphous flowing soul, which is the principle of spontaneous motion. The latter is not understood in its original kinematic meaning but as *biotic movement*.

THE ACT-POTENCY SCHEME

Aristotle accepts an original principle of *potency* (primary matter) and *activity* (essential form). The latter is connected to *goal-directedness* or *teleology*. The term *teleology* originated from the Greek words *telos* (*τέλος* = goal), and *logos λόγος* = concept). It is used for the first time in a writing of C. Wolff in 1728 (see Busche H. 1998:970). In the meantime Greek philosophy manages to move away from a *flowing element* as principle of origin. Empedocles partially de-divinises the divine principle of origin – by splitting it into a divine part (*philia*) and a non-divine part (*strife*) (Empedocles B. Fr.17; Diels & Kranz 1960-I:37). With Anaxagoras the *nous* is seen as self-sufficient, not mixed with anything and independent in itself (Anaxagoras B. Fr. 12; Diels & Kranz 1960-II:37).

PRIMARY MATTER AND SUBSTANTIAL FORM

The initial restriction to static being in the thought of Parmenides was exceeded in the subsequent struggle with the problem of persistence amidst change. The way in which Heraclitus struggled with this problem inspired Plato to realise that the world of becoming presupposes something constant and enduring. Aristotle responded to this problem with his concept of substance. His *hylomorphism* attempts to unite two opposing principles: *matter* and *form*. From the perspective of the substance concept it concerns the relation between *primary matter* and *substantial form*. Aristotle introduced the former in order to account for that which remains the same throughout change, whereas form is seen as the principle of activity (the potency-act scheme).

The relationship between constancy and change actually concerns the kinematic meaning of uniform (rectilinear) motion and the physical aspect of dynamic changes.[2] In Greek philosophy yet another aspect entered the scene, namely biotic aspect. Living entities are associated with having a principle of (physical) motion within itself, while the term *φύσις* (*physis*) refers to the intrinsic nature of something. It is clear that within the development of Greek philosophy alternative *modes of explanation* succeeded each other: number, space, the kinematic, the physical and the biotic. It should not be forgotten, however, that the biotic facet has been present from the very beginnings of

2 In passing we mention that according to Von Fritz, Aristotle's final cause is misunderstood by the modern natural sciences (Von Fritz 1984:126 ff.).

Greek philosophy. What Aristotle had in mind with his understanding of *physis* is seen from his use of the term *entelecheia* (*ἐντελέχεια*). He employed this term in coherence with the above-mentioned two others: *ἐνέργεια* and *δύναμις* (*act* and *potency*) (Aristotle *Metaphysics*, Book 9; Aristotle 2001:820 ff.). His thought reveals the two equivalent concepts, *energeia* and *entelecheia*.

MECHANISM AND VITALISM

Greek philosophy generated the long-standing controversy between *mechanism* and *vitalism*. In the ensuing struggle between these two opposites yet another issue had to be dealt with. It concerns the question of whether the universe could be explained in terms of one principle only (*monism*), or whether two (mutually exclusive) principles are needed (*dualism*).

Hans Jonas strikingly typifies the monistic forms of vitalism and mechanicism. Unlike dualists, monists do not attempt to reduce reality philosophically to two fundamental principles, but rather posit a single all-inclusive and universally explanatory principle. We may therefore indeed speak of *pan-vitalism* and *pan-mechanicism* as *monistic* stances. However, Jonas does point out that the traditional conflict within biological thought between vitalism and mechanism from its inception is one-sided. When Thales believes that *everything lives* it is inconceivable for such a view that "life" is not the normal and governing rule in the universe. Jonas remarks: "In such a worldview, death is a puzzle which stares humankind in the face, the antithesis of the natural, self-explanatory and understandable, that which is the common life" (Jonas 1973:20). The heading of this paragraph is: *Pan-vitalism and the problem of death* (Jonas 1973:19). The opposite view is found in the thought of those who think *pan-mechanistically*. They emphasise that the phenomenon of life finds itself on the boundary of the encompassing homogeneous physical world. Quantitatively life is negligible in the immeasurability of cosmic matter; qualitatively it is an exception to the rule of material characteristics; and epistemologically it is the unexplained in the explainable physical universe. "Conceiving life as a problem here means that its strangeness in the mechanical world, which is *the* reality, is recognised; explaining it means – on this level of the universal ontology of death – denying it, relegating it to a variant of the possibility of the lifeless" (Jonas 1973:23). This paragraph appears under the heading: *Pan-mechanism and the problem of life* (Jonas 1973:22ff.).

PHYSICALISM AND AN IMMATERIAL VITAL FORCE

Philosophers soon realised that one cannot define everything, because every definition not only requires the use of certain *terms* but presupposes the employment of terms that cannot be further defined. Accepting self-evident "primitive" terms avoid the danger of an infinite regress in a demonstration. Aristotle considers this insight to be so deeply rooted in the Greek philosophical mind that not disposing over it demonstrates a lacking

intellectual education. In connection with the possibility for the same thing to be and not to be, which, according to Aristotle is "the most indisputable of all principles," he states:

> … for not to know of what things one should demand demonstration, and of what one should not, argues want of education. For it is impossible that there should be demonstration of absolutely everything (there would an infinite regress, so that there would still be no demonstration); but if there are things of which one should not demand demonstration, these persons could not say what principle they maintain to be more self-evident than the present one (Aristotle *Metaphysics* 1006a4-12; Aristotle 2001:737).

On this fundamental level of philosophical reflection one may now ask: can one define the *physical* and the *biotical*? This question concerns both material (physical) and living (biotic) things. Greek philosophy would employ the terms "matter" and "form," whereas the terms *hylozoism* and *hylomorphism* are capturing both of them. The *efficient cause* (in German: "Wirkursache") specifies the structuring mechanism while the *final cause* captures what is intended in a teleological (goal-directed) understanding of things.[3]

The earlier mentioned pan-mechanism and pan-vitalism aim at opposing goals. The former wants to define "life" purely in mechanical (or physical) terms, whereas the latter wants to explore the biotic aspect of organic life as ultimate mode of explanation.[4] The mechanization of nature since the Renaissance is a familiar theme within the domain of the philosophy of science, in particular owing to the well-known work of Dijksterhuis (1969). It entails that modern physics, until the end of the 19th century, was dominated by the theoretical attempt to explain the universe in terms of "particles-in-motion."

Alongside this development *idealistic morphology* continued the legacy of Plato – compare the classification system developed by Ray and Linnaeus[5] – and within biology itself, particular schools of thought orientated themselves to the biotic aspect. Trends such as vitalism, holism and organismic biology are critical of the dominant physicalistic position represented by neo-Darwinism. In particular one may mention the standard textbook of the Austrian botanist, Wilhelm Troll, *Allgemeine Botanik*. In this work he continues the legacy of *idealist morphology* (Troll 1973).

LIMITATIONS OF THE SUBSTANCE CONCEPT

Aristotle assumes that the combination of matter and form yields the substantial unity of an entity. When this view is applied to the relationship between atom and molecule

3 Medieval philosophy continued Aristotle's distinction between a material, formal, efficient and final cause. See the explanation of Gould (2002:1187 ff).

4 Thus Adolf Meyer, in his analysis of the concept of wholeness, holds that the basic conceptions of physics should to be deducible from those of biology while the latter are not reducible to the former. Entropy, for example, would be a special case of biotical disorganisation; the uncertainty principle would follow from the psycho-physical relation; and the principle of relativity would be derivable from the relation between organism and environment (Needham 1968:27 note 34).

5 Ray employed the total morphology of organisms to classify them, not merely one feature or organ as in the past. See Linneaus 1735, pages 1-12.

the substantial unity of the latter will eliminate the persistence of atoms with their own substantial unity (see Hoenen 1938:326). Hoenen launches a similar argument in respect of living entities. Hoenen writes: "because a living entity is one substance it cannot be an aggregate of substances. It is a totality; its substantial unity typically belongs to the *ens*. If the components were actually present in the living entity then it would have been at once actually one and many in substance, thus in the same respect, which is absurd" (Hoenen 1938:325).[6] This view does not allow for the continued actual presence of atoms, molecules and macromolecules within living entities.

The exceptional regenerative phenomena present in animal life, investigated by Hans Driesch, severely challenged the traditional mechanistic machine model of living entities. Experimental work done on sea urchins (*Echinus microtuberculatis*) has shown that machines cannot be divided and still remain intact, whereas at the early developmental stages of sea urchins they could be divided into two, three or four parts, each being capable of complete regeneration. It is simply inexplicable how machines could continue to be divided (through cell division) and still remain *intact wholes* (see Weber 1999:266 ff., 270 ff.). Driesch considers living entities to be *equipotential harmonious systems*. It captures the fact that each part of a living entity has an equal potential to regenerate the whole system. In the dynamic order of organismic processes a characteristic feature is discerned designated by Driesch as *equifinality.* However, a part that is not separated does not realise its full potential. But then the question is: what is responsible for the maintenance of this balance?

Driesch and his neo-vitalist followers continued the Aristotelian idea of an immaterial *vital force* (*entelechie*). However, he was not aware of the fact that living entities are not physically *closed* systems. For this reason he argues that the increase of order within growing entities calls for an *immaterial force* capable of *suspending* the second main law of thermodynamics, the law of non-decreasing entropy. This law states that within a closed system entropy will increase or remain constant. If living entities are *closed* systems an increase of order will be impossible within them.

Driesch opts for a negative understanding of Aristotelian's vital force (*entelecheia*). He holds that the *entelechie* is a "system of negations" (Driesch 1920:513; 459 ff.). As such no positive determination is possible: "entelechie" is not mechanical; not equal to energy, not a force, not constant (Driesch 1931:460), and it is non-spatial (Driesch 1931:513).

Von Fritz highlights the *structural* orientation of classical Greek thinking and its difference with the modern concern for *predictability*.[7] According to him the lack of appreciating this difference caused a misunderstanding of Aristotle's doctrine on teleology. He refers to the experiments done by Driesch as well as the latter's fruitful

6 "een levend wezen, omdat het eene substantie is, kan niet een aggregaat van substaties zijn; het is een totaliteit; het heeft de substantieele eenheid, die het *eens* eigen is. Waren de componenten er actueel, dan zou het tegelijk actueel één en veel zijn in substantie, dus in hetzelfde opzicht, wat absurd is."

7 The underlying issue here is the switch from the Greek-Medieval substance concept to the modern natural scientific function concept (Strauss 2013).

but largely neglected theory of *structuration* (*Ordnungslehre* – see Von Fritz 1984:126-127). Von Fritz is right in pointing out that although Driesch implements Aristotle's idea of an *entelechie*, he switched to the modern natural scientific understanding of the physical aspect of living entities, which is governed by its concept of causality. Without rejecting the classical mechanistic understanding of matter, Driesch, in fact extends the application of the deterministic concept of law to biotic phenomena. He does it by limiting the traditional mechanistic approach to the material foundation of living entities. A consistent deterministic view of causal laws is found in the thought of Bernard Rensch (Rensch 1991:236 ff.).

Von Fritz refers to Driesch's view that in addition to mechanical, physical and chemical causes, one also has to appreciate *entelechie* as an *efficient cause* (*wirkende Ursache*). The modern view of causality actually contradicts what Aristotle had in mind.[8]

FROM "SUSPENDING" PHYSICAL LAWS TO OPEN SYSTEMS

However, Driesch's embarrassing proposal, namely to contemplate an *entelechie* capable of "suspending" physical laws, was soon superseded. This happened when Von Bertalanffy (round-about 1930) and others generalised the second main law of physics by applying it also to *open systems*. A glacier, fire and all living entities allow for systems with a constant flow of matter or energy. These systems prevail in a so-called *steady state* – which Von Bertalanffy designates as a *flowing equilibrium* (*Fliessgleichgewicht* – see Von Bertalanffy 1973:149). We may add his remark: "If open systems attain a steady state, this has a value equifinal or independent of initial conditions" (Von Bertalanffy 1973:140).

The followers of Driesch changed their views of the "immaterial vital force" in the light of the generalisation of the second main law of thermodynamics. Rainer Schubert-Soldern decided to refer to an "instability factor" in order to account for healthy living things (Schubert-Soldern, 1959 and 1962). It does not come as a surprise that neo-vitalists started to avoid the expression "vital force" which has been so dominant in vitalistic thought since Aristotle introduced his notion of an "*entelechie*." The latter was supposed to be *immaterial*, but then it contradicts the physical connotation of the term *force* as it appears in the expression *vital force*.

When a living entity is investigated from the perspective of its biotic function, one may hold that something alive is in a stable state, designated as *being healthy*. At the same time, by focusing on the physical aspect of living entities (compare Schrödinger's work on the physical aspect of the cell), with a view to the flowing equilibrium of its physical-chemical constituents, one can affirm that it is in an *unstable state*. When the physical-chemical substratum of living things approaches a state of higher statistical

8 "Aber Aristoteles wäre auch nie auf den Gedanken gekommen, die Entelechie, oder vielmehr die *φύσις* [physis], die er gelegentlich als bewirkende Ursache des Entstehens und der Entwicklung der Lebewesen bezeichnet, al seine zusätzliche Ursache neben isolierbaren physikalischen und chemischen Ursachen einzuführen" (Von Fritz 1984:127).

probability, biotical instability increases as a sign of the final process of dying. Also Von Bertalanffy sensed the shortcomings of reductionist attempts aiming at an elimination of the biotic aspect of reality. In 1973 he writes:

> These processes, it is true, are different in a living, sick or dead dog; but the laws of physics do not tell a difference, they are not interested in whether dogs are alive or dead. This remains the same even if we take into account the latest results of molecular biology. One DNA molecule, protein, enzyme or hormonal process is as good as another; each is determined by physical and chemical laws, none is better, healthier or more normal than the other (Von Bertalanffy 1973:146).

A "CENTRAL INSTANCE" AND INTELLIGENT DESIGN (ID)

During the past three decades the traditional vitalistic theories appeared once more in the form of diverse theories of *intelligent design*. From the perspective of the history of philosophy it continues the Greek idea of a *Workmaster* (*Demiurge*). Already in the thought of Anaxagoras the *nous* is portrayed as the divine form-giver, but over against itself it finds matter as an original principle of origin. In dialogue *Timaeus* Plato speaks of a *demiurge* which gives form to this original matter. The term *design* is the equivalent of the German term *Bauplan* (structural design) and is employed by (neo-)Darwinists and (neo-)vitalists. Even Stephen Gould oftentimes employs the term *Bauplan* in his last large work on the structure of evolutionary theory (see for example Gould 2002:582, 1156, 1198, 1202).

In his version of neo-vitalism the biologist Johannes Haas ascribes an inherent law or programme to a living entity, preferably designated as its *life plan*: "The life plan contains as components the blueprints of each of its expressions; the genetic plan for their succession; the functional plan for carrying out its activities; the behavioural plan for all its 'acts' " (Haas 1974:336). These life plans have an ideal being and do not allow a physical-chemical explanation: "Physical-chemical forces and laws are in themselves unable to bring forth the structures of meaning which we identify as the life plan, and even less can it produce a non-material bearer of life plans" (Haas 1974:355).

Following the above-mentioned idealistic-morphology of Troll (1973:19 ff.), Walter Heitler speaks of a *Zentralinstanz* which must exist in every organism (Heitler 1976:6). He employs this expression in an attempt to avoid physicalism. He calls upon the totality character of typical living entities, since neither physics nor chemistry is acquainted with a genuine concept of a *Gestalt* or *Ganzheit* (Heitler 1976:3). There is a "central instance" directing the teleological operations of living things. Heitler calls it the "biologischen Instanz" (biological instance) which specifies also the sub-instances (*Unter-Instanzen*) of organs, cells, and organelles (Heitler 1976:16).

According to Von Bertalanffy the modern intellectual development commenced with the mathematical *more geometrico* approach, followed by the mechanistic world view. He is convinced that the organismic world view supersedes the just-mentioned developments:

> First came the developments of mathematics, and correspondingly philosophies after the pattern of mathematics – *more geometrico* according to Spinoza, Descartes and other contemporaries. This was followed by the rise of physics; classical physics found its world-view in mechanistic philosophy, the play of material units, the world as chaos ... Lately, biology and the sciences of man come to the fore. And here organization appears as the basic concept – an organismic world-view taking account of those aspects of reality neglected previously (Von Bertalanffy 1968:66).

The complexities involved in the relationship between the chemical building blocks of living entities and their biotic properties (such as growth, maturation, ageing, adaptation, differentiation and integration) became so overwhelming that within neo-vitalist circles Aristotle was criticised as a *vitalistic monist* (Haas 1968:39). He argues that the Aristotelian conception regarding the role of matter within an organism cannot be maintained. He states that within living entities matter functions within its own sphere and does not obtain it from the "forma substantialis" as claimed by Aristotle.[9] However, it is a pity that Haas understands the intertwinement of the physical and biotic dimensions of organisms in terms of a *dualistic* perspective: "The being of organisms therefore include two mutually different realities, a material and an immaterial component, from an ontological perspective they therefore have a dualistic constitution" (Haas 1968:39).[10]

As an effect of the increasing detail-knowledge regarding the micro-dimensions of living entities, various scholars recently increasingly call for an acknowledgment of these complexities while confessing our ignorance regarding possible ways of accounting for the origination of the first living entities. Proponents of intelligent design (ID) point out that scholars from diverse fields contemplate the implications of ID (for example Van den Brink 2005:316). In 1996 Michael Behe published his work on Darwin's *Black Box*. He states that in Darwin's times nothing was known about the micro-dimensions of the living cell, symbolically captured by referring to Darwin's *Black Box*. In this work he explains what he calls *irreducible complexity*. It generated much controversy and scholars from various fields and orientations critically discussed Behe's arguments. Ten years later a second edition appeared. In his "Afterword" to the second edition Behe (2006) remarks that "although the cultural dynamic is still playing itself out, a decade after the publication of Darwin's *Black Box* the scientific argument for design is stronger than ever." He continues: "Despite the enormous progress of biochemistry in the intervening years, despite hundreds of probing commentaries in periodicals as diverse as *The New York Times*, *Nature*, *Christianity Today*, *Philosophy of Science*, some scientists at the highest levels, the book's argument for design stands. ... there is very little of the original text I would change if I wrote it today" (Behe 2006:255).

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9 The German reads: "Die Materie, die als Mittel und Instrument des organischen Lebens fungiert, besitzt ihr Sein und Wirken in eigener Regie und erhält es nicht nicht erst von der 'forma substantialis' " (Haas 1968:30).

10 "Die Organismen bestehen also aus zwei seinsmässig voneinander verschiedenen Wirklichkeiten, einer materiellen und einer nichtmateriellen Komponente, sie haben also ontologisch betrachtet eine dualistische Konstitution."

More recently (2013) another book was published, causing just as much controversy. It is the work of Stephen Meyer on what he calls *Darwin's Doubt*. This extensive work highlights a twofold concern:

(i) With reference to the standard natural scientific literature, the first concern is about the relatively short period of time involved in what is known as the "Cambrian explosion" (the earlier estimates of about 30 million years are now brought down to about 6 million years).[11]

(ii) The concern that the standard gene-centric approach of neo-Darwinism cannot account for the *epigenetic* source of complex new body plans. (What is needed for mutations "to produce new animal body plans," namely "*beneficial* regulatory changes expressed early in development" do not occur (Meyer 2013:262).

Meyer mentions that ORFfan genes (derived from "open reading frames of unknown origin") are found in plants, animals as well as eukaryotic and prokaryotic cells. Since they do not have homologs ORFans cannot be related to a common ancestral gene. This fact is acknowledged by more and more Darwinian biologists who currently attempt to "explain" the origin of such genes through *de novo* ('out of nowhere') origination" (Meyer 2013:216).

ID theories ultimately attempt to account for the existence of *types* – in particular for the *law* of specific *kinds* of living entities, i.e., for their *type laws*. The main focus of Meyer's book is on *body plans*, on what Gould designated as the *Bauplan* (structural design) of different kinds of living entities. This shows that in spite of radically diverging assessments the contemporary scene still echoes the legacy of Aristotle. Von Fritz even argues that looking for causes is much more difficult than simply recognising that a chick will mature into a chicken – an ordinary experience of teleology within our everyday lives (Von Fritz 1984:126).

CONCLUDING REMARKS

Since theory formation always explores certain modes of explanation, the effect of elevating one mode of explanation above all others normally results in the theoretical perspective of a *monistic* orientation. Interestingly, it was precisely these monistic inclinations, already found in Greek philosophy, that served the on-going scientific development in the West in discerning what is truly irreducible.

11 Sterelny points out that the standard (neo-)Darwinian account runs "slap-bang into a nasty fact," namely that about 530 million years ago most "major animal groups appeared simultaneously". He continues: "In the 'Cambrian explosion', we find segmented worms, velvet worms, starfish and their allies, mollusks (snails, squid and their relatives), sponges, bivalves and other shelled animals appearing all at once, with their basic organization, organ systems, and sensory mechanisms already operational. We do not find crude prototypes of, say, starfish or trilobites. Moreover, we do not find common ancestors of these groups (Sterelny, 2001:89-90; New Edition 2007:116).

The monistic thesis of the Pythagoreans, namely that everything is number, through the discovery of irrational numbers caused a switch in orientation within Greek thinking towards the geometrisation of mathematics. According to Stafleu they have shown that "spatial relations cannot be explained by numerical relations" (Stafleu 1987:61). Wieland correctly defends the view that this development resulted in the recognition of the fact that the continuum is irreducible (Wieland 1962:287). The founder of intuitionistic mathematics, LEJ Brouwer, defends a similar view in his dissertation of 1907. John Bell mentions that for Brouwer "continuity and discreteness" are "complementary notions, neither of which is reducible to each other" (Bell 2006:217) while fully paying attention to Aristotle, who was the first to undertake a "systematic analysis of continuity and discreteness" (Bell 2006:30). Aristotle consistently rejected the idea that continuity could be derived from distinct elements (see Bell 2006:32-34).

Heraclitus, Plato and Aristotle contemplated the problem of constancy and change in reaction to the one-sided emphasis of Heraclitus on change. Zeno's paradoxes actually demonstrated the irreducibility of movement to space. Stafleu declares: "Zeno's paradoxes can be interpreted to demonstrate that motion cannot be explained by numerical and spatial relations." Alternatively, Zeno's paradoxes may be seen as a means of accepting motion "as an unexplained principle of explanation" (Stafleu 1987:61).

Both Plato and Aristotle realised that change presupposes persistence. The material world of becoming correlates with Plato's supra-sensory static ideas and with Aristotle's universal substantial forms, which are also not subject to change. However, the notion of *form* remained ambiguous since it could be related both to the physical and the biotic. Regardless of whether or not "matter" (the physical) or "life" (the biotical) is assumed to be the primary reality, these elements are still present both in *hylozoism* and *hylomorphism*. This shows that these two terms indeed still capture an element of the lasting influence of Greek philosophy in the intellectual legacy of the West.

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