

WHAT ‘HAS LIFE POTENTIALLY’?

Janice T. Chik*

Janice Chik Breidenbach, Ave Maria University, United States

Abstract

The origin of life in the cosmos poses some perplexing philosophical problems. For instance: Does life exist at the very beginning of the cosmos, or does it emerge at a specific moment that occurs later in the earth's natural history?

Keywords

origin of life • original vitality • vital elementalism

Introduction

The origin of life in the cosmos poses some perplexing philosophical problems. For instance: Does life exist at the very beginning of the cosmos, or does it emerge at a specific moment that occurs later in the earth's natural history? Abiogenesis, the theory that life originated spontaneously from inanimate matter, raises a metaphysical problem of particular interest to Aristotelians. How can the living be generated from the non-living, if generation of forms requires some prior actuality? If we claim that the vital actuality is in fact already found in the matter that serves as potentiality for all living substances, then nothing is truly without life – which seems absurd. On the other hand, if we maintain at least a historical distinction between living and non-living substances, then the explanatory sufficiency of abiogenesis – particularly of generating something greater from something lesser – remains a challenge.

This paper suggests that the idea of original vitality, or Vital Elementalism, is perhaps not as absurd as it may initially seem. An Aristotelian variant of it may support current scientific hypotheses of the generation of life in the universe. My task in this paper is to explain how an Aristotelian metaphysics of life might be compatible with some variant of Vital Elementalism.

The idea of a vital principle that existed at the cosmic beginning has held appeal since ancient times, for instance in the pre-Socratic idea that various elements might serve as the explanatory core of one's cosmogony. This paper considers whether there might be an Aristotelian version of this idea, and in particular, whether some variation of it might be compatible

with Aristotle's 'Actuality Principle': that for any actualized thing, there must be some prior actuality required for its generation from matter qua potential thing (1, *Meta.* XII, 1072a9).

Abiogenesis and Aristotelian metaphysics

Abiogenesis is the hypothesis that living substances emerged from inanimate chemical matter at some point in the earth's evolutionary history. On the face of it, abiogenesis seems entirely reasonable, supported by a fossil record that seems to suggest living organisms emerged on the scene roughly 3.7 billion years ago, followed by dramatic species diversification in the Cambrian period.¹ The theory has furthermore received support from scientific experiments which appear to show that amino acids can be synthetically crafted from primitive chemical compounds (3).² The so-called 'primitive soup theory' supporting abiogenesis (8), or indeed the hydrothermal vents hypothesis (9), both face a particular challenge from Aristotelian metaphysics: if actuality is prior to potentiality, then how does life emerge from a purely inanimate world? If Prior Actuality is true, then either abiogenesis is false, or we must explain how a purely inanimate world can contain the prior actuality needed to inform the generation of living substances.

1 Precisely when life emerged is disputed by interpreters of the geological records (2). Thanks to an anonymous referee for the clarification.

2 Miller's experiment has since been updated by several studies, such as Szostak et al. (4), Benner and Sismour (5), Sutherland (6), Krishnamurthy and Hud (7), and many others (with thanks to an anonymous referee for the pointers).

* Corresponding author e-mail: janice.breidenbach@avemaria.edu

The challenge of abiogenesis is compelling only if we recognize that the presence of living substances is metaphysically extraordinary within natural history, with a distinct causal history from that of inanimate and non-living things. If life is assumed simply to be a feature of extreme microscopic complexity (10), then the problem of causal discontinuity between the non-living and the living seems mitigated. Yet many philosophers, and not only Aristotelians, are loathe to concede that the phenomenon of life is merely a feature of material complexity.

According to Aristotle, all living things are distinguished by some non-material principle, which animates such matter by organizing it into a unified whole with specific actualized powers. Following Plato and other pre-Socratics, Aristotle calls this principle the 'soul': the 'first actuality of a natural body that has life potentially' (11, *De An.* II.1, 412a28-29), or 'the first actuality of a natural instrumental body' (11, *De An.* 412b6). Material stuff would otherwise not have bodily organization, lacking the principle of unity that makes it the kind of thing it is.

What provides the existence of this first actuality of a natural kind? What grounds the principle *itself*, of a living thing's existence? What actualizes the actuality of a living body, such that it naturally 'has life potentially'?

Aristotle's response is that there always is *some* prior actuality to provide the actualization of everything that is: hence the argument for the eternity of the universe. Otherwise, there would be creation *ex nihilo*, which is impossible by his lights. Every substance can be generated only by some prior substance. So the potentiality of life in any natural body is a potentiality conferred by this prior actuality. Without such actuality, there could be no coherent concept of a 'body that has life potentially'.

Abiogenesis therefore poses a special problem for Aristotelian metaphysics. Aristotelians are committed to the existence of natural kinds, whose variety and differentiation are specified in formally distinct ways. Living forms in particular represent natural kinds whose specification cannot be explained in inanimate or exclusively material terms. The principle of Prior Actuality entails that most materialist versions of emergentism, or naturalistic emergentism, cannot be invoked to explain how living forms are generated from purely inanimate elements or substances.

There is nothing particularly modern about naturalistic emergentism. As early as the pre-Socratic period, the philosopher Anaximander, we are told,

believed that there arose from heated water and earth either fish or animals very like fish. In these, humans grew and were kept inside as embryos up to puberty. Then finally they burst, and men and women came forth already able to nourish themselves. (Censorinus, *On the Day of Birth* 4.7, fragment 12A30)

Anaximander says that the first animals were produced in moisture, enclosed in thorny barks. When their age increased they came out onto the drier part, their bark broke off, and they lived a different mode of life for a short time. (Aetius 5.19.4 = 12A30) (12)³

For many pre-Socratics, the principal element supportive of life is water (Thales) or moisture in general (Anaximander); Anaximenes hypothesized it was air, and Pythagoras famously considered fire to be the principle element for cosmic evolution. An extremely facile form of abiogenesis is described in fragments such as these, based on the belief that some original cosmic stuff must be responsible for the emergent generation of life. The pre-Socratic hypothesis was that the emergence of life and its diversification is based on a metamorphosis of incidental properties rather than true substantial generation. If animal life emerges like new leaves and buds on the branches of trees, then different species and forms are merely different modes of physical change, much like the phase sortals of water according to its different physical states, from liquid to gas or solid. On the Aristotelian view, modern emergentism seems no better than these ancient explanations of abiogenesis. How can material elements by themselves be responsible for the extraordinary emergence of living organisms and the diversity of complex animal species on earth? Put another way, how do material elements come to be constituents of an animal qua living substance? Metaphysical emergentism as an explanation for abiogenesis threatens more than Prior Actuality: Aristotle's organic homonymy principle suffers a conceptual collapse if we accept naturalistic emergentism. There would be no basis for claiming that proper parts of living animals (hands, feet, eyes) acquire a vitally informed metaphysical status qua parts of the animal, a status lost when the same microphysical elements are severed from the whole.

Vital elementalism

The ancient preoccupation with a single cosmic substance from which all other things are derived led some pre-Socratics to invest material stuff such as water, air, and fire, with vitality prior to the living organisms they constitute. I refer to this view as Vital Elementalism: the possibility that life is already

³ Cited by Cohen et al. (12, p. 10).

found in the principal elements of the universe. These living elements come together in a great variety of ways to form a seemingly infinite range of living organisms.⁴

Some say the soul is mixed in with the whole universe, and perhaps this is why Thales supposed that all things are full of gods. From what is related about him, it seems that Thales too held that the soul is something productive of motion, if indeed he said that the lodestone has soul, because it moves iron. (11, *De Anima* I.2 405a19-21)

Anaximenes determined that air is a god and that it comes to be and is without measure, infinite, and always in motion. (13, *On the Nature of the Gods* 1.10.26)

Some of them [the Pythagoreans] declared that the soul is the motes in the air, and others that it is what makes the motes move. (11, *De Anima* I.2 404a17)

The advantage of Vital Elementalism is that it explains the presence of vital substances there is no causal discontinuity in nature between what is alive and what is not, because *everything* is alive. But not all the same things are alive at the same time: a dead cat is no longer a cat, since that would entail that something dead is alive, but rather it is a collection of living microbes. Everything is alive, according to Vital Elementalism, but not everything that has life has the same identity conditions. This is apparent in the constitutive relation: Pythagorean living motes or Thalesian ensouled magnets are not only material stuff out of which living animals are made but are living substances themselves. How else to explain how life emerges from apparently material elements?

The fossil record concerning abiogenesis is not compelling for Vital Elementarists, simply because the evidence by itself seems compatible with either the emergence of life from inanimate matter or the possibility that the elements supportive of living organisms are themselves alive. Some modern scientists hypothesize that organic molecules existed at the very beginning, whether natively or exogenously (14).⁵

Despite its advantages, Vital Elementalism comes at the cost of denying the distinction of life forms over non-vital forms

⁴ Anaximenes theorized that processes of condensation and rarefaction resulted in the transformation of elemental matter into the plurality of identifiable substances, according to Theophrastus, quoted by Simplicius, *Commentary on Aristotle's Physics* 24.26-25.1 (12, p. 10). Empedocles argued for earth, water, air, and fire as 'roots' or 'elements' mixed and separated in various ways by the forces of Love and Strife (12, pp. 43-44).

⁵ Consider for instance the 'panspermia hypothesis', a variation of which was defended by Anaxagoras, which posits that the seeds of life were planted on earth having traveled from other planets (14).

of matter. Since it asserts that the elements themselves are living substances, it also counts as a variant of panpsychism, such as the monadology defended by Leibniz (15). Koons argues that fundamental particles cannot qualify as substances because particles lack substantial or *per se* unity over time, as evidence by quantum entanglement, in which the system 'contains in some sense...two particles, and yet there is no distinct identity associated with either particle' (16, pp. 90-91). Substantial unity is that which confers the individual identity possessed stably by living organisms. In contrast, the indeterministic nature of fundamental particles entails that 'we cannot assign definite active or passive powers to any particles *in isolation*' (16, pp. 92-93). Their instability precludes elemental particles from possessing the substantial unity necessary for qualifying as substances, much less living things.

Since the elements themselves cannot be substances, Koons supposes that abiogenesis is correct: life originated at some non-incipient point in cosmic development. 'Organic substances came late to the history of the cosmos. Unless we are willing to embrace Leibniz's somewhat wild speculation and assume that the world is full of living organisms, we must do something about the inorganic world' (16, p. 99). Even if we reject Vital Elementalism's extreme claim that elemental matter is itself ensouled or vitally substantial, we can still consider fundamental particles to be parts of living substances, in ways that overcome a strict delineation between what is substantially alive and what is not *per se* alive. Koons suggests that 'we could even go so far as to say that quantum particles have only a *virtual existence* until they come to be manifested in interactions between substances. This accords nicely with the fact that quantum particles lack any individual identity' (16, pp. 99-100). We might add that this conditional form of existence also accords well with Aristotle's organic homonymy principle, on which the parts of a living animal have their identity only on the condition that they are unified as part of the substance. The relationship between the living animal and its elemental matter is not so metaphysically opposed as to generate an insurmountable challenge of causal discontinuity in nature: their relationship is interdependent, while preserving the intuition that there *is* a fundamental distinction between the living and the non-living. Of course, we still are left with the need to explain how vitality emerges from inanimate elements, if abiogenesis is assumed to be true.

Cosmic fission (or precipitation)

Some Aristotelians have proposed that life emerged from a single original substance or set of macroscopic substances. Koons suggests:

Rather than imagining that the world began (after the Big Bang) as a cloud of autonomous particles, from which larger structures eventually emerged, I suppose that the early universe consisted entirely of large-scale substances (initially, perhaps, a single, cosmic substance), from which smaller entities gradually precipitated (16, p. 75)

Simpson similarly frames his account of the cosmos as a 'womb of the worlds' – an original 'substance which *always* contained the potentiality for life' (17). The comparison to a womb evokes images of the incipient cosmos as an animal zygote, at times slowly and at times rapidly unpacking the potential contained within its incipient cells, unfolding from a single cell into a unified organism with many discernible, proper parts:

If hylomorphists were to build on the metaphysical proposal that the world began as a single substance which underwent ontological fission, they might think of this primordial substance as *containing* the potentialities for all the other substances the world currently contains. The intuitive idea is that all of these potential substances get 'unpacked' in the course of a cosmic process involving different phases of emergent complexity, in which new kinds of substances (for example, living substances) are generated at later stages which are neither reducible to nor supervene upon substances that existed at earlier stages (for example, chemical substances). All of these other substances, however, remain embedded in the cosmic substance. Far from being a barren void, the cosmic space in which we find ourselves situated would be a veritable 'womb of the worlds'; a substance which *always* contained the potentiality for life. ...if the cosmos began as a single substance, it could have a power for *self-dividing* (like an amoeba, for example), and that such a cosmology need not involve a rejection of any of the fundamental principles of Aristotle's philosophy of nature (17).

Let us call the view that life emerges not from elemental or autonomous particles but rather an original substance or substances, 'Cosmic Fission'.⁶ My version entails that the 'phases of emergent complexity' that unfold in the cosmos are emergent, but not necessarily in the standard *emergentist* sense, such as that advocated by O'Connor (19) and O'Connor and Wong (20). On the standard emergentist view, novel, more complex powers and properties (such as the unique attributes of living forms) are produced exclusively from lower, less complex powers and properties (such as the attributes of non-living, chemical

forms), which survive the macroscopic generation. Koons calls this 'ontological emergence', on which the lower-level constituents survive the generation of macroscopic substances. The problem is that 'this comes close to a kind of vitalism or dualism, and its plausibility is weakened by our natural reluctance to posit new fundamental forces. In addition, O'Connor assumes a kind of original or primordial *universality* of the micro-level, which must contain in a virtual way all the higher levels' (13, p. 75).

According to Cosmic Fission, in contrast, it is not the microscopic elements by themselves that generate a complex, macroscopic living organism, but rather some pre-existing form or actuality in the cosmos that utilizes the elemental particles as material for more complex substances – without the novel substances supervening on or reducing to any simpler, prior existing substances. Indeed, many of the prior particles or substances are necessarily destroyed in macroscopic generation.⁷ On this point, Simpson's account diverges from Koons's: the former wishes to retain the original cosmic substance, in which all current substances 'remain embedded', while Koons posits a form of 'ontological escalation' on which the original substance has been annihilated but possibly enjoys 'some kind of *virtual* or *dependent* existence within the fused entity' that is generated (16, p. 74). Retaining actual existence of the original cosmic substance, however, apparently violates Jonathan Schaffer's 'tiling constraint', on which no two substances can overlap (22, 23, p. 38), cited by Koons (16, p. 77).⁸ Furthermore, Simpson would need to account for the cosmic substance's other constituent substances, including inorganic entities such as Koons's 'thermal substances' (16, p. 106). If all substances are embedded constituent parts of a single cosmic substance, then some parts of the original substance are alive and others are not. But this violates Aristotle's organic homonymy principle, that every constituent part of a living thing is a part of that thing qua living: every part of an animal is a living part of it. Either we concede that everything in the cosmos is and always has been alive, or accept that there is no overlap between an original cosmic substance and the plurality of substances that exist, both as animals and as inanimate entities.

To be sure, Simpson has good reasons for defending the persistence of the original cosmic substance, based on a nuanced interpretation of quantum entanglement. One way

6 There is a third possibility, not considered here, that is proposed in Simpson and Koons (18): that the cosmos is a non-substantial hylomorphic entity. This proposal represents an entirely distinct alternative from Cosmic Fission.

7 Koons accepts Humphreys's (21) account of emergence by fusion, on which 'the entities of the smaller-scale levels are literally destroyed in a diachronic process of fusion (the generation of the new, larger-scale entity)' (16, p. 74).

8 Koons argues that 'if organisms are substances, then the tiling constraint rules out the possibility that the cosmos is also a substance' (16, p. 95).

out of the above challenges is to disavow the claim that the embedded substances are in fact constituent parts of the original cosmic substance, conceding that metaphysical overlap might be possible between at least two substances, perhaps as an exception to Schaffer's tiling constraint. Another advantage of Simpson's position is that the original potentiality for life persists while being actualized in the proliferation of living substances; for Koons, in contrast, the potentiality for life is annihilated alongside annihilation of the original cosmic substance, which begs an explanation of precisely what (or whose potentiality) is being actualized. Resolving these difficulties will require further discussion beyond the scope of this paper.

The priority of Aristotelian actuality

By itself, Cosmic Fission's metaphor of self-division or precipitation leaves undetermined the precise mechanisms by which the cosmos diversifies and proliferates into the variety of life forms in existence. Even if these mechanisms can never be fully specified, we need some way of defining the process as resulting in a restricted set of actualized forms (for instance, corresponding precisely to every substantial natural kind on earth). Without Aristotle's principle of Prior Actuality, how can the potentiality of the original cosmic substance be limited at all? What is to prevent its potentiality from being infinitely unbounded, a cosmic *apeiron*⁹ limited by nothing and expanding into nothing? What defines potentiality so that it unfolds stably and develops specifically into a certain kind of substance, its members generated predictably according to an inherited life form? Aristotle's insight is that potentiality cannot do this on its own: we must specify some further principle by which it comes to have the capacities that it does.

Aristotle argues that this principle is simply what he means by 'nature' (*phusis*): a principle of change specifically belonging to a natural kind, which exists prior to any member of that kind. Prior Actuality therefore presumes that there is a natural fit between certain kinds of matter and the actuality of living forms. But there seems to be a kind of circularity involved in this presumption. To claim some material potentiality is suited for being actualized as living requires positing that the actuality of life is prior to it, such that the form of life has already pre-determined the matter to be suited for being actualized as a living substance. Resolving the apparent circularity requires recognizing that for Aristotle, it is not possible to conceive of any material existence without its already being actualized in some

way: all matter is enformed, and the material potential for life is enformed in a particular way. Generation from such matter always requires a prior existing form as the primary source of a thing's existence; for this reason, generation *ex nihilo* is a metaphysical impossibility for Aristotle (24, *Physics* VIII.5-6).¹⁰

Prior Actuality does not entail that every specific actuality existed prior to potentiality. It only posits that some actuality for life exists prior to all substances. Combined with Cosmic Fission, this account allows for vital development that is compatible with some varieties of naturalism, especially those that presume ontological escalation; it is compatible with both an Aristotelian eternal universe and a theistic concept of creation *ex nihilo*. At the same time, Cosmic Fission avoids creationism, the implausible view that all living forms actually existed simultaneously at the cosmic beginning. It also leaves open the possibility of theistic creation and intervention at crucial moments of evolutionary history, covered by theological explanations that are not exhaustive nor exclusionary of natural causation in the origin of life or consciousness on earth.

If life is present from the beginning of creation in a potential but not actual sense, then the roots of cosmic growth contain vitality after all. Vital Elementalism may be vindicated, if we accept that the incipient elements serve as the material potentiality for the actualization of living substances. We can accept that the incipient cosmic matter contains life potentially, while affirming the intuition from abiogenesis that the appearance of living substances is a metaphysically extraordinary moment in natural history. The distinction between life and the inanimate world is like the distinction between being and non-being. We can take the Parmenidean route and assume that these are mutually exclusive categories or processes. Or we can notice, as Aristotle did, that the inanimate world is inherently replete with the potentiality for life.

¹⁰ Since 'everything that moves is moved by something' (256a2), Aristotle reasons that the historical sequence of generation could not proceed infinitely, but rather must be moved by some ultimate form of self-moving actuality: 'Since movement is eternal, the first mover... will also be eternal' (259a6).

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⁹ The *apeiron* was Anaximander's idea, developed from Thales: typically, translated as 'boundless' or 'infinite'.

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