

**Keys to life:
developments from Schrödinger
to Kauffman and Ward**

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Introduction

There are as many perceptions of what life is as there are disciplines, cultures and worldviews. Typically, most interpretations take human life as the yardstick of all forms of life. Often the different disciplines consider their own premises normative.¹

Biological research suggests that we may soon be capable of generating life ourselves.² Genome research indicates that we will be able to intervene meaningfully to prevent diseases and ‘improve’ life.

The aura of mystery that surrounds life was part of a broader attitude of respect for life, especially in Christianity (to mention but one religion). Up to the early 20th century respect for life and the association of life with mystery were largely backed by philosophical, theological and scientific thought. Life is the supreme value. Without it everything becomes meaningless. Traditionally religions regarded it as a gift from God, the creator and sustainer of all life on earth. While God was the source of all life, human life was particularly meaningful because humans were created in God’s image. Many qualities were attributed to this image, but basically they boil down to the assertion that, unlike other forms of life, humans are endowed with consciousness, language and a capacity for worship. The life of all other organisms, therefore, is subordinate to theirs. Humans recognise the will to live in other organisms and know that they themselves have a will to live in

¹ Just think of some metaphors that try to convey what life is. Modern scientific metaphors express life as information, codes, chance, necessity, emergence. Philosophically it is envisioned as a journey, a stage, a dream, a mystery. Religious metaphors depict it as a gift or a summons, stewardship and husbandry, precious and vulnerable, sinful. Present-day techno-scientific jargon conceives of life as virtual, a program, an interaction between software and hardware. In everyday naïve experience the question is probably considered rhetorical and in no need of an answer. Most metaphors for life are reductive, since they usually focus on just one particular aspect/form of life.

² In January 2007 a team of bio-engineering researchers at the University of California, San Diego reported that they had developed a working computer simulation of all biochemical metabolic reactions that occurred in human cells. This required consultation of 1 500 books, review papers, and scientific reports in order to construct a database of 3 300 separate metabolic reactions (Regis 2008:174 n1).

the midst of other forms of life that share this will. Nonetheless nonhuman forms of life are all subject to human beings and their life. Thus human life was seen as unique and in due course acquired a metaphysical attribute in the form of an immortal soul.

All that has changed. The challenging issue in theology is the possibility of life without the need for a creator God. How do we conceive of life in a closed cosmological, physical, evolutionary model? In such a model life expresses itself in an incalculable multiplicity of forms (species) and in its supreme form: intelligent consciousness. In this supreme form of life the searching mind reaches the insight that human beings are pure chance, doomed to ephemerality and obliteration in oblivion. Yet these limits are exceeded by the attribution of a host of meanings at ethical, aesthetic, religious and other levels. Intelligent consciousness is unique and, in a framework of 'strong' emergence, it creates the possibility of creating new realities that operate top-down. Focusing on intelligent consciousness as a key to any reality and the driving force behind the creation of new realities brings to light diverse forms of transcendence as a paramount mode of perceiving the world. It leads us to conclude that the question of life is one that human beings need to answer because it affects them fundamentally. After all, the answer affects my entire life: its purpose, meaning, design and how to take responsibility for it. All other answers have to further this project.

But maybe we have had our fill of philosophical and religious speculations about what life is.³ Answers offered to the question were overwhelmingly anthropocentric. Genome research shows that all life is one,⁴ interrelated, evolved over aeons and underwent dramatic change. At the same time all life rests on physical premises and presuppositions that made it possible.

³ When it comes to defining life Regis (2008:146) observes aptly: "The definition of 'life' has invoked innumerable seemingly interminable discussions, ranging from the religious to the philosophical and metaphysical. Still today no definition is universally accepted, and the advisability of even proposing definitions is controversial." (Also see Regis 2008:158.)

⁴ Wilson (2002:131-132) writes: "All organisms have descended from the same distant ancestral life form. The reading of the genetic codes has shown thus far that the common ancestor of all living species was similar to present-day bacteria and archaeans, single-celled microbes with the simplest known anatomy and molecular composition." Proof of the universal common decent of all organisms, for example, is the fact that the living cells of all earthly creatures share the same basic methods, means and modes of operation: they express their genetic code to translate gene sequences into amino acids, and make use of the same twenty amino acids as the building blocks of proteins (Regis 2008:110). "Because all organisms have descended from a common ancestor, it is correct to say that the biosphere as a whole began to think when humanity was born. If the rest of life is the body, we are the mind. Thus, our place in nature, viewed from an ethical perspective, is to think about the creation and to protect the living planet" (Wilson 2002:132).

Edwin Schrödinger's *What is life?*

The significance of Schrödinger's book *What is life?* is that he gave the biology of his day a new face by taking it into the domain of physics; that he inspired a whole generation of biologists, who eventually discovered DNA and ushered in genome research; and above all, that he underscored the unity of all existence. That unity flows continuously, from inorganic to organic life, and from organic to sentient life.

For many biologists Schrödinger's work put paid to the notion of vitalism. Watson (2003:34-35) writes: "A small minority of scientists still thought life depended upon a vital force emanating from an all-powerful god. But like most of my teachers, I disdained the very idea of vitalism." Following Schrödinger's input, resistance to any irrational belief in a life force or spirit grew. Vitalism contravened science: Watson (2003:35) writes: "If such a 'vital' force were calling the shots in nature's game, there was little hope life would ever be understood through the methods of science."

Vitalism was among the first answers to the question whether the world was more than just matter. An early example was the Boyle-Hobbes controversy in Puritan England. It centred on the question whether atomic particles are propelled by their own inherent operation or are driven by extrinsic forces. The Puritans, like Boyle, upheld the dualism of matter and spirit. A providential God, not chance, was responsible for all motion in the universe. Hobbes believed that all matter was endowed with soul and that spirit was immanent in nature. Thus nature operated autonomously. (Du Toit 2007:116-117). Various other attempts followed. The transcendent or supernatural is invoked to account for forces operating in the world but at the same time transcending it; diverse forms of supervenience are proposed by proponents of emergence, who maintained that complex systems cannot be reduced to their underlying levels but transcend them, and exercise a top-down influence. Vitalism posits some principle as the real mystery of life, be it nous, soul or supernatural energy, Spirit or the God concept. Thus Jean Fernel, the great physicist of the 16th century, saw the life spirit as the real mystery of life. The notion of a life spirit has a mystical dimension; it permits the idea of agency/causality, leaving scope for God and other life forces and phenomena; it allows for concepts like immortality and the soul. But it leads to denigration of the body and physical life (neo-Platonism, Paul); it introduces dualism: the soul merely dwells temporarily in the physical body: "... spirit has the brain for habitation, its temporary dwelling ... Matter was the servant. Spirit, mind, was the master" (Sherrington 1953:230).

We may have moved beyond Aristotle's (4th century BCE) and Galen's (2nd century CE) concepts of *élan vital*, but that does not spell the end of all 'more than' thinking. Vitalism is essentially a metaphor for 'more

than ...'. In that sense the present-day concept of emergence also amounts to vitalism, a 'more than' metaphor. It is an x factor causing new realities to emerge. It is based on natural laws, but these do not necessarily lead to predetermined outcomes. Emergence stresses the 'more than' factor as well but differently from all previous versions of vitalism.

Schrödinger's book *What is life?* (1992), which has sold over 100 000 copies in seven languages, inspired an entire generation of researchers. At the end of World War II many young physicists were shocked by the military use of atomic energy and just hearing one of the founders of quantum physics ask, "What is life?" was sufficient to fire their enthusiasm and change their avocation from physics to the life sciences.⁵ In Schrödinger's view physics underlies all life. That raised the status of biology: "In the mid-twentieth century, physicists and biologists were very different creatures. Physicists brought a different attitude and ambition to biology – an attitude and ambition that ... revolutionized first biology, and then neuroscience" (Smith 2005:216).

The unity between physics and biology was a major implication of Schrödinger's book. Right at the beginning (Schrödinger 1992:8) he points out that every organism (including the mind [Schrödinger 1992:9]) is based on exact physical laws. The accepted view was that the creative hand of God or some supernatural creative force intervened between inorganic matter and living organisms. Hitherto we have not been able to establish a linear connection between matter and life. Could concepts like codes and information bridge the gap? If so, we can affirm a continuous line from physics to biology. Watson (2003:xx) writes the following about the double helix: "The double helix is an elegant structure, but its message is downright prosaic: life is a matter of chemistry." Life is natural and is based on physical laws and other factors like information and codes. But being natural does not make it predictable. We know that all phenomena are based on natural laws, but we cannot tell what phenomena may yet evolve. That is where numbers, chance and time come into it.

The physicist is familiar with the fact that the classical laws of physics are modified by quantum theory, especially at low temperatures. There are many instances of this. Life seems to be one them, a particular striking one. Life seems to be orderly

⁵ Maurice Wilkins was one of these young physicists. He had worked on the Manhattan Project during the war and, turning against physics, transferred his interest to biology after reading Schrödinger's book. He joined Randall's group at King's College, London, and used his physics to investigate the structure of complex biomolecules, in particular the nucleic acids, and ultimately shared the Nobel Prize with Watson and Crick (Smith, C.U.M. 2005, footnote 2).

and lawful behaviour of matter, not based exclusively on its tendency to go over from order to disorder, but based partly on existing order that is kept up (Schrödinger 1992:68).

In the final chapter, entitled “Is life based on the laws of physics?” (Schrödinger 1992:76), Schrödinger, without using the term, sees life as in some sense supervenient on the laws of physics: “... from all we have learnt about the structure of living matter, we must be prepared to find it working in a manner that cannot be reduced to the ordinary laws of physics” (Schrödinger 1992:76). But he does not invoke a supernatural force or *élan vital* to account for life. “And that not on the ground that there is any ‘new force’ or what not, directing the behaviour of the single atoms within a living organism, but because the construction is different from anything we have yet tested in the physical laboratory.” This, in fact, was the challenge that many biologists took on.

Transitions and emergence in Kauffman’s work

Transition from nonlife to life

Advances in the life sciences and research technology increasingly suggest that life and nonlife are one and the same. The more minutely we observe it, the more difficult it becomes to discern a dividing line. We might still distinguish between life and nonlife, but they are no longer readily separable. We have to admit that any line we posit from the basic physical components to the highest form of life might be a very long line – so long that the unity may well be obscured by the multitude of intervening events. And because of that multiplicity, metaphysical factors may well find their way back into the chain of evolutionary events. Metaphysical factors refer to circumstances that give rise to totally new creations not determined by natural laws, in which complexity, creativity and environmentally contingent factors play a role. They are developments based on bio-physical factors but not reducible to them.

As Sir Charles Sherrington, a major influence on Schrödinger’s thought, (1953:209) points out:

Aristotle noted of life that its lower limit defies demarcation. The living and the non-living, he thought, merge one in the other gradually. To-day the very distinction between them is convention. That deletes ‘life’ as a scientific category; or, if you will, carries it down to embrace the atom. The vanishing point of life is lost.

Sherrington (1953:229) finds this reductive: “Natural science has studied life to the extent of explaining away life as any radical separate category of phenomena. The categories of living and lifeless as regards science disappear; there is no radical scientific difference between living and dead.” But what some find reductive strikes others as broadening the vision. It makes sense to link life with the evolution of the cosmos and pinpoint the inter-relationship between everything.

Kauffman (2008:71) writes: “But we can say at a minimum that it is scientifically plausible that life arose from nonlife, probably here on Earth. It is also plausible that we will succeed in creating modestly complex self-reproducing chemical non-equilibrium reaction systems capable of heritable variation.” Regis (2008:96-97) maintains that the evolution of life was almost inevitable, given the circumstances on our planet. All that is required for life is a number of proteins that need some amino acid combinations to function. The earliest organisms date back about 3.85 billion years, while our planet only became solid 3.9 billion years ago. That means life originated the moment it became possible and, according to Kauffmann (2008:159-160), it duly happened through a process of autocatalysis. “Catalysts sped up chemical reactions in a way that offered possible shortcuts to the genesis of life” (Regis 2008:97).

Kauffman (2008:45) objects to the need for a radically transcendent creator God:

If life is natural as I firmly believe, then part of the immense call for a transcendent Creator God loses its force. If we seek a reinvented sacred based on this universe and its miraculous creativity, then a natural explanation for the origin of life in this universe is of paramount importance.

The ‘space’ left for the creator God to act is relegated to circumstances preceding the big bang, or linked to the determination of natural laws, or pantheistically is some obscure way to all physical processes or to the various possibilities that led to the emergence of life. It is but a small step to name natural law, blind evolution, chance, emergence, creativity “god”.

Kauffman (2008:129-130) insists that factors like creativity, agency, meaning, values, purpose, life on our planet cannot be reduced, either epistemologically or ontologically, to physics. At last, after 400 years, we can rid ourselves of the Galilean spell that everything will ultimately be explicable in terms of natural law (Kauffman 2008:142).

For Kauffman the origin of life is due to the myriad of possibilities offered by nature itself. He (2008:64) uses the term ‘adjacent possible’ to indicate the exponential growth of life and possibility. He admits “that the

early Earth almost certainly had only a small diversity of organic molecules, perhaps a hundred or a thousand different compounds. Today there are trillions of different organic compounds spread out among the roughly 100 million living species. The biosphere has exploded into its chemical adjacent possible.” He observes similar explosions in economic and general human history: “The creativity in the universe is tied to the explosions into the adjacent possible” (Kauffman 2008:64).

Given the huge range of possible developments and combinations and the role of chance, it follows that the outcome of development is unpredictable. Chance is a magic word in evolution theory.⁶ It plays a major role in genetic evolution, which is not possible without mutations: “Without mutations, we would have exactly the same set of genetic information and billions of us would all resemble each other in much the same way that identical twins resemble each other ... The term *mutation* refers to a startling large array of different types of processes that can permanently change the structure, and thus the information content of genes” (Richards & Hawley 2005:9).

Emergence

Kauffman (2008:34) defends his view “that epistemological emergence means an inability to deduce or infer the emergent higher-level phenomenon from underlying physics. Ontological emergence has to do with what constitutes a ‘real’ entity in the universe: is a tiger a real entity, or nothing but particles in motion, as the reductionist would claim? If the tiger is a real entity in its own right, it is ontologically emergent with respect to the particles comprising it.” Epistemological emergence is the idea that complex systems cannot be described, in practice, in terms of their component units because of our epistemic limitations, that is our inability to do the computations. According to ontological emergence, on the other hand, full understanding of complex systems in terms of their components is not possible in principle, not just because of practical considerations, but because new levels of causality appear at higher levels of organisation.

It should be noted that we observe the emergence of individual entities and promptly reduce them to certain building blocks. But things never evolve in isolation. Innumerable entities emerge simultaneously and interrelate with as many incalculable factors, which in their turn influence one another and are ‘more than’, for instance, the evolution of a genetically encoded biological program. These are the same old factors that we have always termed ‘environmental’. There are just as many environmental factors that are no

⁶ Boyer (2010:45) writes: “The raw material of evolutionary processes is variation. No variation, no natural selection.”

less unique and unrepeatable, and their impact on evolution history is equally incalculable.

As an example of ontological emergence not determined by natural laws⁷ (although based on them) Kauffman (2008:37) cites the notion of preadaptations. “I will show that the problem is more than epistemological; it is ontological emergence, partially lawless, and ceaselessly creative.” Preadaptations are part of evolutionary history and characterise human mental activity. They are previously acquired evolutionary developments that are adapted to fulfil entirely new functions. To some extent this is lawless (Kauffman 2008:35). Kauffman describes two classical examples. One is the swim bladders of fish that palaeontologists trace back to some early fish living in oxygen-poor water, some of which reached their lungs that absorbed the air bubbles, thus enabling the fish to survive. “But now water and air were both in a single lung, and the lung was preadapted to evolve into a new function – a swim bladder that adjusted natural buoyancy in the water column” (Kauffman 2008:132). The other example is the three bones in the human inner ear that evolved from Darwinian preadaptations of the three jaw bones of a primitive fish (Kauffman 2008:139-140).

The same ‘innovative’ feature of evolution applies to the human brain. “The human brain, like a ghost ship, keeps slipping free of its computational moorings to sail where it will. It does so because it is nonalgorithmic. This freedom is part of the creativity in the universe” (Kauffman 2008:188). The notion of a nonalgorithmic brain implies that it could be acausal, and since quantum mechanics is acausal, the brain is partly quantum mechanical (Kauffman 2008:204). That raises the question how the quantum system of pure possibilities leads to actual classical events. Kauffman (2008:205, 207) proposes the solution of quantum phase decoherence, based on a loss of phase information. “I will make use of decoherence to classical behavior as the means which a quantum coherent conscious mind of pure possibilities can have actual classical consequences in the physical world” (Kauffman 2008:208).⁸ Kauffman’s solution is important because it means that mind is not at the mercy of pure causality. In a strictly causal model “[m]ind cannot

⁷ Kauffman maintains that emergence transcends natural law. That is because he sees emergence as so unique, unpredictable and unrepeatable that natural law, which implies regularity, order and universality, becomes inapplicable. “We cannot say ahead of time what novel functionalities will arise in the biosphere” (Kauffman 2008:37). “Biology is therefore not reducible to physics. Biology is both epistemologically and ontologically emergent” (Kauffman 2008:39).

⁸ Kauffman (2008:210) uses the example of chlorophyll to substantiate his proposal. Chlorophyll molecules capture photons and antenna proteins retain them. Chlorophyll maintains quantum coherent states for a long time (750 femtoseconds, as opposed to chemical bond vibrations (1 to 1.5 femtoseconds). This enables chlorophyll to absorb photon light energy and process it into chemical energy. Kauffman uses this principle as analogy to explain the quantum aspect of brain functioning (Kauffman 2008:211, 214).

act on matter, because brain already does ... Again, if brain states are already sufficient causal conditions for subsequent brains states, then there is nothing left over for mind to do in acting on matter” (Kauffman 2010:224-225). His acausal model, by contrast, implies that quantum coherent expressions of the Schrödinger wave result in possibilities rather than causes – an interpretation that precludes epiphenomenalism and the concomitant criticism of it.

Kauffman reintroduces metaphysics and religion into the question about life. The sacred dimension he opts for is creativity, and one wonders why he does that. Why this need to preserve the sacred and reinvent it? Why Kauffman’s plea for metaphysical space? Creativity may be seen as sacred, great, unpredictable, but it is impersonal, without agency and therefore not on the same level as the theistic God. Creativity might be a useful metaphysical metaphor in a closed physical worldview. But it can be seen as a process and to believers God is usually much more than a process. Creativity could also be explained in terms of all the processes it entails, which all contribute to the emergence of a particular ‘ontological entity’.

Kauffman’s idea that physical reality needs to be ‘augmented’ is noteworthy. This ‘more-than-the-purely-physical’ is given religious significance: it becomes the sacred. Personally I would have confined it to metaphysical significance, simply because the processes described in physics and biology are so awesome, the chance that gives rise to them so mind-boggling and the time that they took to evolve just a figure on paper which fails to convey the actual period, that we inevitably have to resort to metaphysics.

Referring to the possibility that molecular reproduction need not be based solely on the symmetry of DNA or RNA, Kauffman (2008:57) writes: “Again we come to a multiple-platform argument: it appears that life, like computation, may be independent of the underlying physics.” This argument posits that there are various platforms (springboards) from which molecular species can launch their collective autocatalysis, hence forms of life. If molecular reproduction could be a result of the emergent properties of complex chemical reaction networks, then the emergence of life is far more probable than we may have thought, although Kauffman (2008:57) is careful to add that that emergence cannot be reduced to physics. Thereupon Kauffman (2008:59) boldly posits: “My own theory of collectively autocatalytic sets suggests that their formation is highly probable ... Such emergence would not be reducible to physics. And life, in the sense of molecular reproduction, would be expected, not incredibly improbable. If so, our view of life changes radically. Not only does life not need special intervention by a Creator God, it is a natural, emergent expression of the routine creativity of the universe” (also see Kauffman 2008:71).

Kauffman’s is a fresh attempt to maintain the natural order without freezing it in closed, law-governed determinism. He is careful to avoid every

form of reduction without forfeiting scientific integrity. He acknowledges the speculative nature of some of his proposals, which may yet be scientifically substantiated at some future stage. His abrogation of deterministic linear causality is augmented with examples of possible new forms of emergence that permit the totally unexpected.

But can one worship creativity or one's own amazement? It is not clear why he cannot accommodate his view in, say, the Christian framework. What, for instance, is the difference between deifying creativity and deifying Jesus? The focus is still on human traits such as life, mercy, reconciliation, acceptance and empathy, even if they are presented as divine. Christianity and many other religions are equally characterised by remarkable expressions of the same creativity and instances of the unexpected emergence which he values so highly.

This is an example of immanent transcendence that unfolds from below and adheres to the laws of nature as we know them. It has the same impact on human consciousness as radical or absolute transcendence. Even though it may be experienced as holy, mysterious and life enhancing it is not supernatural.

Keith Ward: consciousness the fulcrum of reality

But in light of present-day ideas on information, energy, complexity and emergence vitalism could also be interpreted differently. Among critical idealists Keith Ward is an example of a thinker who sees consciousness as the fulcrum of all reality. To him it acquires divine features because it determines reality, yet exists independently of it.⁹

Ward interacts critically with Gilbert Ryle's notion of a Cartesian entity ("ghost in machine") that accounts for intelligent consciousness. Instead Ward opts for idealistic dualism, because he finds materialism less plausible than dualism. What makes him noteworthy is that issues like metaphysics, dualism and mind-matter interaction are resurfacing in light of recent developments in the biological and cognitive sciences. Naïve materialism and physicalist reductionism are rejected fairly unanimously. But in how far can approaches like idealism, critical idealism, new forms of metaphysics and faith be accommodated in a scientific frame of reference?

⁹ "But it implies that minds are different from matter. They therefore could in principle be decoupled from matter, as any effect could in principle be decoupled from its source" (Ward 2010:116). But that is an illusion. Thought, at whatever level of emergence, is at all times dependent on brain. Of course mental products can be objectified into cultural artefacts that exist independently of the generating mind, but to be of any use they have to be re-assimilated by intelligent consciousness in a particular context.

The physical sciences are having a greater impact than ever, not only on the human sciences but also on naïve religious faith.

Can reality exist without intelligent consciousness? What actually is consciousness? We can measure the brain activities that give rise to it, but consciousness itself is not measurable (see Ward 2010:15). Does consciousness and mental constructs based on human experience open a window on reality, or is access to the world restricted to empirical scientific research (in itself impossible without innumerable mental constructs)? Like all material entities the brain relies on mental constructs and would not exist as it appears to us without constructive mental activity (Ward 2010:44).

Ward maintains that “there is a reality underlying our everyday experience whose basic character is consciousness or mind”. He rightly identifies the challenge to find an appropriate concept of personhood (Ward 2010:62, 63). But in this context ‘appropriate’, in his view, signifies that human consciousness is absolute, thus emphasising the close link between mind and matter (“minds are fully integrated into an evolving universe”, Ward 2010:81); a more controversial point is his view that all reality is in some way conscious. “What idealists maintain is that the ultimate nature of reality is mind-like,¹⁰ and that human and other finite minds are the best clues we have to what objective reality is like ... Human minds generate an idea of reality as mind-like in a way that far transcends human mentality, yet that does include something like consciousness, value, and purpose as essential parts of nature” (Ward 2010:58; also see p. 189).

This is not surprising, considering Ward’s view that any understanding of reality derives from consciousness or human experience (Ward 2010:99). Everything noteworthy in human consciousness is transposed to the cosmos, with the result that we credit it with the same inbuilt teleology that characterises the human mind (Ward 2010:88ff, 90). “Even the laws of nature exist for a reason, and the best reason is that they exist for the sake of desirable goals which the universe may realize” (Ward 2010:185).¹¹ But does Ward add anything new to the realism/anti-realism debate? It seems that scientific developments since bishop Berkeley (Ward 2010:26) yielded nothing that affected his basic premise. His claim to speak on behalf of all idealists is simply not true. To my mind Hegel’s view of the relation between

¹⁰ Here Ward is supported by Erwin Schrödinger, whose *What is life?* concludes with a section on Vedanta philosophy, in which he says that individual consciousness may well be a manifestation of cosmic consciousness: “The only possible alternative is simply to keep to the immediate experience that consciousness is a singular of which the plural is unknown; that there *is* only one thing and that what seem to be plural is merely a series of different aspects of this one thing, produced by a deception (the Indian MAJA)” (Schrödinger 1992:89).

¹¹ Whilst admitting that teleological explanations rightly belong to philosophy, Ward (2010:99) points out that nobody can avoid some form of philosophical presupposition.

humans and reality is far more differentiated, because people constantly learn from their interaction with the world.¹² If human consciousness determines reality, we must ask whose consciousness – the scientist's or the naïve opinion of the man in the street? Nobody has access to all human consciousness simultaneously. One only thinks of one thing at a time (Schrödinger). Does that mean that realities that do not feature in one's mind at a given moment cease to exist? Or that the fanciful, illusory world in which a particular person lives or the dream world exists only because it is a mental activity?

More important is the question whether consciousness can in fact serve as a fulcrum of ontology. Viewed phenomenologically, consciousness rather comprises everyday trivialities. If reality is determined by consciousness, then worldviews are largely anthropomorphic, the tacit background to our ongoing intentionalities and desires. A scientist who views consciousness purely materialistically as a product of electrochemical brain processes is not governed by this concept in her daily existential dealings with reality. This in its turn leads to dualism between the techno-scientific world in which we function and our naïve life world of personal relationships, faith, imagination and desire, which is overall governed by other principles. It moderates claims to a holistic worldview, which would have only theoretical value. Human consciousness is too dynamic to operate with just one philosophical system. When a person's mind is restricted to a particular traumatic event it is pathological (e.g. post-traumatic stress syndrome). Even though our consciousness includes our culture, background and experience, it does not mean that a particular conception of, say, the materialist character of reality necessarily determines all the contents of consciousness, let alone the subconscious mind.

Reality is not determined by consciousness – on the contrary, reality (natural, cultural and other environments) determines consciousness. We grow up with a preconceived interpretation – or misinterpretation – of the world. Our worldview is adjusted throughout our lives. Ward's so-called critical idealism displays no critical aspect; it is an absolute idealism, possibly an alibi for persistent notions of the existence of the soul (Ward 2010:197) and a hereafter (Ward 2010:122). To my mind his idealistic reductionism does not get the science-religion debate any further.

¹² The following is an example: "True Substance is a being that truly is Subject, i.e. which only is itself in so far as it alienates itself from self, and is then able to posit itself in and through what is thus alien. It cannot exist as a simple, positive starting-point, but only as a part of a self-separating, self-returning movement, which negates itself in different, external otherness, and then reasserts itself as the negation of all such otherness" (Hegel 1979:497). The Subject (read consciousness) cannot exist without the other (alien, foreign objects, persons, reality), it acquires substance from (getting to know) reality and, armed with that knowledge, returns to itself.

The answer is neither a reductive physicalism nor a reductive idealism. The real challenge is to accommodate human sentiments like faith and hope as plausibly as possible in a scientific worldview. Schrödinger is a case in point. While he helped to put biology/life on a par with physics/nonlife, he nonetheless repudiated sweeping objectification: "... just stating the fact that 'the world of science' has become so horribly objective as to leave no room for the mind and its immediate sensations" (Schrödinger 1992:120). He continues:

Mind has erected the objective outside world of the natural philosopher out of its own stuff. Mind could not cope with this gigantic task otherwise than by the simplifying device of excluding itself – withdrawing from its conceptual creation. Hence the latter does not contain its creator (Schrödinger 1992:121).

He does not dwell on the subject any further, but it clearly includes the grandeur of creation and human interpretations of it. It is easier to make these interpretations and ascribe them to God than to assume responsibility for our interpretations and their consequences. Possibly Schrödinger has the courage of his convictions and is prepared to assume personal responsibility for the implications of his thinking.

Summary

Schrödinger's attempt to link the physical world of atoms and molecules with the question of biological life was surprisingly successful and inaugurated a new dimension in biological research (Watson and Crick). The more insight we gain into the world of nature, the more we realise how closely the different levels of reality are interlinked, but we also realise the unpredictability of the phenomena arising from new, more complex levels of emergence. The history of evolution cannot be attributed solely to linear causality. The emergence of new realities creates the impression that the presence of favourable conditions, so to speak, pulls existing levels of development to higher levels. Deacon (2008:114) issues a caveat in this regard: "A purpose, conceived as the 'pull' of some future possibility, must be illusory, lacking the materiality to affect anything." It should rather be seen as an invitation:

The Western mind sees causality primarily in the presence of something, in the pushes and resistance that things offer. Here we are confronted with a different sense of causality, in the form of an 'affordance': a specifically constrained range of

possibilities, a potential that is created by virtue of something missing (Deacon 2008:120).

Emergence cannot be used as a magic wand to incorporate teleological factors into the history of evolution. In this regard Clayton's warning (2008:308) is apposite:

one can endorse levels of emergence up to a certain point without being required to accept higher and more speculative levels of emergence, yet those who endorse the 'higher' levels must acknowledge that these levels remain dependent on the levels that precede them.

Human consciousness is probably the supreme, most complex form of emergence. As the highest level of development, it imposes our conceptions of the world on reality. That does not make them true: they remain subordinate to scientific evidence. But at the same time consciousness is the supreme form of creativity and imagination – the level at which we impose meaning on our lives. Making that supreme level of consciousness the fulcrum of reality as Ward does is taking it too far, because human consciousness cannot be fathomed without due regard to all the underlying levels.

“Since we hold life to be sacred, we are stepping towards the reinvention of the sacred as creativity in nature” (Kauffman 2008:71). Maybe we will soon be able to create life in the laboratory. But will we be able to determine a good life – or tell what constitutes a good life? Something of this conundrum emerges in God's questions to Job.

The last word must go to Lord Sherrington (1953:273):

Granted the scope of natural science be to distinguish true from false, not right from evil, that simply makes the man of science as such, not the whole man but a fractional man; he is not the whole citizen but a fraction of the citizen. The whole man now that his mind has 'moral values' must combine his scientific part-man with his human rest. Where his scientific part-man assures him of something and his ethical part-man declares something to be evil it is for the whole man in his doing not to leave it at that. Otherwise in a world of mishap his scientific knowledge and his ethical judgement become two idle wheels spinning without effect, whereas they have been evolved and survive each to give the other effect.

Because science qualifies the scientist as 'a fraction of the citizen', the need for the sacred should probably be seen as a need for a sense of wholeness and integration.

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