The down to earth pole of understading the complexity of life

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Abstract:

This paper argues that the down-to-earth pole of the understanding of the complexity of life is made up by a threefold factor, namely the interplay of geology, microbiology, and evolution. It is such intertwining that provides the ground for life as we know it. This paper claims that the origins of life are contemporarily the origin of the biosphere as a living system. Dualism must be overcome at all costs; hence, there is not physics, say, geology on the one hand, and biology on the other hand. On the contrary, both make up a highly integrated complex system. The approach suggested in this paper conveys a phenomenological endeavor as a non-substantive comprehension of life and the living systems. Life, it can be safely said, is non-causal, and a self-organizing and autopoietic phenomenon. An evolutionary view of life implies hence after an open-ended understanding. At the end the paper explores the consequences of such a take.

Key Words: Geology; Microbiology; Biosphere; Evolution; Complexity science; Phenomenology; Plate tectonics

Resumen:

Este artículo defiende una comprensión de polo a tierra de la complejidad constituida por un triple factor, así: el entrelazamiento entre geología, microbiología y evolución. Es esta triple articulación la que se encuentra en la base de una comprensión de la vida tal y como la conocemos. La tesis de este artículo afirma que el origen de la vida es contemporáneamente el origen de la biosfera como un sistema vivo. El dualismo debe ser superado de manera radical. De esta suerte, no hay, de un lado, la física, digamos, la geología y, de otra parte, la biología. Por el contrario, ambas constituyen un sistema altamente complejo. La aproximación sugerida en este trabajo comporta una visión fenomenológica y por tanto no sustancialista de la comprensión de la vida y de los sistemas vivos. La vida, cabe decir, no es causada, sino, es un fenómeno autopoiético y autoorganizado. Una visión evolutiva de la vida implica en consecuencia una comprensión abierta de la vida. Al final se exploran las consecuencias de una visión semejante.

Palabras Clave: Geología; Microbiología; Biosfera; Evolución; Ciencias de la complejidad; Fenomenología; Tectónica de placas

Introduction: From ontology to phenomenology

Even though this paper will not directly discuss the origins of life it should be clear from the outset that understanding rightly the origins of life should absolutely overcome the Cartesian dualism between *res extensa* and *res cogitans*; say, between the natural and the social sciences. In sharp contrast with Descartes, C. Lyell, the founder of geology, knows about the interplay between physics and culture, body and mind, the natural and the human.

The story of science has been usually seen as linear and fragmented partially due to a linear view of time and history. Geology is born in 1830 thanks to C. Lyell. Microbiology is developed around the second half of the 19th Century thanks to pioneering work by Pasteur and Koch. The theory of evolution was conceived independently by Wallace and Darwin in the 19th Century, but it was born in 1859 when Darwin published *The Origins of Species by Means of Natural Selection.* The trouble, though was that this theory encountered numerous hurdles, was misconceived and misinterpreted, and needed nearly one more hundred years to be fully accepted. S. J. Gould has told this magnificent story in a compelling boog (Gould, 2002).

Geology can be said to set out the ground on which not only the game of life takes place, but also the basis for a right understanding of life. Straightforwardly said, there is no life on Earth. Instead, the planet itself is alive, and therefore it must receive another name – for names may imply understandings and explanations. “Earth” or “planet” are physical concepts, as it happens; they implicitly assess dualism, namely stating physics on the one hand, and biology on the other. A sound name for a living planet can be *biosphere*, a term originally coined by E. Suess, but properly developed by V. Vernadsky (Vernadsky, 1998).

Margulis and Lovelock named it as Gaia. Anthropology teaches that originally each ethnic people and culture conceive of earth as a living organism and has and had had a particular name for it.

Microbiology is probably the best outcome of the invention of the microscope first invented in 1590, by Janssen, father and son, but fully implemented and applied by R. Cook in his *Micrographia* de 1665, a keystone in microscopy (Cook, 1995). The observation of a huge, deep and fascinating world "down there" revealed a most fascinating chapter in the history of life, namely the roots, vestiges, and real foundations of life itself.

Well, once geology and microbiology joint the name of the game is evolution.

This paper aims at showing that the interplay between geology and microbiology serves the ground for the correct understanding of the complexity of life. Life emerges and is supported from the bottom, so to speak, from its very roots, not from the branches. The human centered view of life is wrong simply because it takes a branch for the whole tree, and remains blind or completely oblivion of the roots. Literally, the real life of the tree of life happens underneath in the unseen dimension of the intertwining between earth and life. Significantly, we must turn to the invisible to grasp the real nature of life - the invisible or the dimension underneath, which Is not necessarily the hidden.

Yet, the argument of this paper claims that life is a complex process uniting geology and the variety of life forms which is spontaneous, acausal and self-organizing. Life creates the conditions for its own emergence and sustainability while shaping the planet and harnessing the conditions created for life to exist. Much more than centered around the question about the origin of life, this paper turns around the conditions that make life possible – something that is usually taken for granted.

Descartes' error must be overcome by all means. The division between animated and unanimated matter is untenable, particularly nowadays. Such assumption is simply wrong, period. Geology and microbiology are, so to speak, two sides of one and the same token. Life creates the very conditions for its emergence and its sustainability. More exactly, there are not external conditions –generally taken as physical or physical-chemical conditions, that, therefore, make life possible. Although different from each other, there exist two ways to grasp this idea, namely autopoiesis and self-organization. Both mean that life is *causa sui*, certainly a highly counterintuitive idea.

Geology serves as the gate to understand what classically was the unanimated dimension of this world. The inner core – solid, the outer core – liquid, the stiffer mantle, the rigid mantle up to the crust, both the basaltic and the granitic, the continents and the oceans, up again to the atmosphere and the asthenosphere, geology opens up the gates to the "external conditions" of life, whereas, on the other side, microbiology serves as the "internal conditions"

and the most basic expressions of life. The distinction however is merely analytical or epistemological. For both geology and microbiology are one and the same thing, namely the hardcore of life on Earth. The Earth, one of the most conspicuous places of evolution – as it is known.

1–. Geology as the voice of nature

Geology is the name for the fantastic processes – generally referred to as: forces, that are literally beneath life and the living phenomena. However, already from its beginning, Lyell conceived of geology as the investigation about "the successive changes that have taken place in the organic and inorganic kingdoms of nature; it enquires into the causes of these changes, and the influence which they have exerted in modifying the surface and external structure of our planet" (Lyell, 1997: 1). Geology shapes the very face of life on Earth as well as its behaviors, the entire history and the real and possible landscape of the biosphere at large.

Rightly speaking, there is no difference between the geosphere and the biosphere. The distinction is just analytical or epistemological.

The origins of the biosphere are exactly the very same origins of the solar system, for both processes happen in a congruent story. The story of the biosphere is well known and it has been told several times (Hands, 2017). Meaningfully it is an organism made up of numerous fluctuations having a membrane, namely the geomagnetic flied, which is closely intertwined with both the presence of the moon and the central core of the planet, made up of a fantastic incessantly moving nucleus of iron – which can be said to be a sort of mitochondria. Life is not just a causal phenomenon, but a highly complex weave of numerous factors, relations, interactions and loops, that behave directly as well as indirectly, with both positive and negative feedbacks.

By and large, the most important implications in life at large are indirect inferences. These have been named as uncertain inferences (Kyburg, Jr. and Teng,2001). Indirect inferences are non-trivial inferences. More exactly direct inferences of the kind A → B have come to be recognized as trivial ones. Good science is about non-trivial implications. To be sure, the relationship between geology and microbiology are mainly indirect – subtle, if you wish.

The existence of fluctuations and perturbations, turbulence and instability is the landmark of life at large. In physics as well as in mathematics living beings are asymmetrical, and the rupture o symmetry is probably the most salient feature of life. We live in a restless universe (Born, 2013). Two basic fluctuations are closely intertwined in the story of life in the Blue Dot. These are the plate tectonics and the biogeochemical flows. Both trigger the Hadley and Ferrel cells which are crucial for the dynamics of life and the emergence and existence of biogeography, i.e. panbiogeography (Craw *et al.*, 1999). In other words, it is all about the diversity and dynamics of life. As it is well known, the plate tectonics is made up

by six major plates and twelve minor plates. The borders of the plates have been identified as destructive, conservative and constructive. Once again, the distinctions are basically analytical or epistemological.

This is the crux of the entire story: life is as diverse as imaginable. In biology and ecology, to say the least, there is always an exception. Therefore, against a physicalist approach to the world, the issue is not about trends, generalizations or matrixes, but about exceptions. Exceptions are what make us think – and live. Translated in the language of logics, the complexity of nature lies not in universal quantifiers but in particular or singular quantifiers – the ones like: "sometimes x", or "x happens and yet, y...", or also, "some x, but a few y....", and several others.

Indeed, it is almost impossible to turn one's sight around and not find life – from extremophiles up to animals and plants. There are currently more than one hundred definitions of life, and none is correct. This means, we simple do not exactly know what life is, as yet. This paper argues that this a motive for optimism – in research and thinking. To say the least, life is not an entity of any kind but a relationship, a connection, or also a process, a weave.

Life is nonlinear dynamics, and the game of life is of an upmost highly complexity. Fluctuations, symmetries, perturbations and instability are the milestones or most salient features of life at large. Biologically speaking, this all is about adaptation and change.

Indeed, along with the dynamic phenomena and systems just mentioned above rivers, lakes, seas and oceans on the one hand as well as earthquakes and volcanoes on the other hand are the weaves that shape life. Biogeography is weaved with forests and valleys, deserts and coasts. Let's put it straightforwardly: life is a geological layer (Craw *et al.*, (1999). Dispersal and vicariance appear as the understanding – causes and effects, of the distribution of life on the planet, i.e. the patterns and processes of life as-we-know-it. Moreover, a study of geology allows also to grasp the processes and patterns of life as it-could-be possible.

It is the motion of tectonic plates which governs the evolution of ecology at every moment or period. The topographic features and the climate are at the same time the outcome and the causes of geological processes. Plainly said, the richness of life on Earth is one and the same thing with the variety of physical, say, geographical and geological varieties and subtleties.

Viewed from the bottom-up, there is no distinction of any kind between physical and chemical processes and biological, ecological and cultural dynamics.

In this sense, geology can be viewed as the earthly name for randomness – which is one of the creators of life. Randomness adopts a twofold face, thus: as radiation and as the

environment. Geological processes encounter in volcanic eruptions, plate tectonics and earthquakes expressions and materializations of randomness. Indeed, in spite of refined tools and rods, neither the eruptions of volcanoes, nor earthquakes can be predicted. Metheorology, as it is well known, was the cradle for the birth of the science of chaos (Lorenz, 1995). A chaotic phenomenon is a highly ordered system, albeit quite unpredictable. It should nonetheless be remembered that Wegener, the discoverer of the plate tectonics, was a meteorologist, too.

Indeed, randomness acquires a most proper name as the environment or also as the processes that take place in or as geology. Thus, earthquakes, typhoons, hurricanes, the eruption of volcanoes and draughts and spontaneous fires for example shape the entire story of life. Not to mention exorbitant phenomena in the outer space such as meteorites, black holes, the eruptions of the sun and supernovas, to name just a few of them. Life it appears controls a few systems but the most important one, namely the environment remains out of control. To be sure, geology is the ground name or the most concrete materialization for the environment and hence for randomness.

As it can be easily seen, the biosphere is the name of both the outcome and the result of geology and microbiology, at large. Geology compounds not just the continents and the plate tectonics, but also the shapes and moves of the oceans and seas. Arguably, geology is one and the same connection of the Earth with the moon (Kébé, 2019).

It is worthwhile to highlight this: geology comprises ecology. These are two sides of one and the same token. Differently stated, geology is one mode in which randomness happens on Earth. Differently stated, geology opens op the doors to the scenario where physics and chemistry come into play and interplay together with all historical and social sciences.

Arguably, geology implies a catastrophic view of nature in exactly the sense of the sciences of complexity (Cuvier, 2009). This distinction between animated and animated is porous, mobile, inexistent, even. However, such a view is possible when we depart from nature, here geology, and not from humans or from a distinctive pre-conceived definition of life. By derivation, climate is the outcome of the interplay between geology and microbiology. The most fantastic happenings on Earth take place unexpectedly. Unforeseeable dynamics bring the name of geology. Catastrophism and randomness depict the face of life on earth, its history and destiny.

All in all, the biosphere can be safely taken as a fluid. Furthermore, paleomagnetism cannot be grasped separately from the dynamics of life at its various layers, contexts and flows. A distinctive landmark of a complex system consists exactly in explaining it in terms of fluids. At the end of the day, the universe itself seems to be made up of gravitational waves, a phenomenon that was just discovered or detected in 2015.

2-. Microbiology as the body of nature

Microbiology is the view of life in its most basic units and processes. Historically speaking, microbiology is the offspring of biology, a most important achievement by C. Darwin. Microbiology was born in the 19th Century thanks to Pasteur and Koch, mainly, but it is in the second half of the 20th Century until now when it reaches its maturity. The world of microbiology comprises the very seeds of life, from parasites, viruses and bacteria, to extremophiles, spores and algae, fungi, slime and protozoa, and even prions.

To be sure, microbiological entities are real geological forces. C. Lyell made it explicit already at the very origins of geology. Life is an authentic geological force (cfr. Lyel, vol II: 159-160, and many other passages).

Indeed, provided that dualism is overcome, microbiology is one and the same thing with the process of shaping nature's face. More exactly, microbiology is the body of nature, out of which big plants and big animals, the human beings included, can be said as the epidermis of the biosphere.

By and large, viruses also called sometimes as bacteriophages are the most abundant form of living entities in the biosphere (Zimmer, 2021). It is important to highlight the outcome of the Global Bacteriome Project – also called as the Global Human Bacteriome Project, namely human beings are holobiont. This means that for each living cell humans have at least ten bacteria, which means that 90% of human beings are bacteria. Moreover, in the mucous membranes, for each bacterium there are in a human being at least ten viruses. The result is more than surprising: the human component of a human beings is less than 1%. Brand new lights are shed on the classical understanding of a human being is.

Thus, the understanding of life can and must be human-decentered.

Indeed, viruses were typically conceived as non-living organism. More exactly they stand in a threshold between life and non-life, namely between animated and non-animated matter if the distinction was satisfactory – which it is not, as it happens.

Meaningfully, the concept of species is highly questionable, since its foundation are basically anthropological. In other words, speaking of species results highly questionable if not untenable (Cfr. Impey, 2011). In fact, the distinction between plants and fungi, for instance, is fuzzy if not movable. There is not a clear-cut line where the difference can be safely traced between plants, on the one hand and fungi, on the other.

In other words, microbiology is the realm, so to speak, that makes it clear that the opposition between matter and life, between species, in fact, between life and non-life is simply whimsical if not unsustainable. The Table No. 1 provides an illustration about such circumstance:

Table No. 1: Forms of Reproduction of Living Entities

Biological entities	Forms of reproduction
Animals	Sexual reproduction
Fungi	Asexual reproduction
Bacteria	Reproduction as cloning
Viruses	Reproduction by mutation

Source: Own Elaboration

Indeed, life was classically understood in terms of higher sexually reproductive species, to say the least. Microbiology has been radically shaking such assumptions and explanations. We are entering a moment in which the human-based understanding of life and the living beings becomes reductionist. As a consequence, the scope of life has been significantly enlarged.

Sexual and asexual reproduction were the two basic forms for dealing with reproduction. Bacteria were rightly conceived as reproducing themselves asexually. However, as scientific research develops it has been discovered that more specifically bacteria reproduce by cloning (Bobay *et* al., 2015). Furthermore, the pandemic of Covid-19 has permitted understanding that viruses mutate and hence reproduce. Meaningfully bacteria and viruses accelerate evolution horizontally.

Table No. 1 allows understanding that reproduction – a key factor of what life is and does, takes a variety of forms. Thus, the original scope about only two forms of reproduction –sexual and asexual, is enlarged and enriched. The history of science is nurtured by the discoveries made at each step. In other words, it is the present that nurtures the past, not the other way round.

Viruses represent a most conspicuous problem regarding the understanding of life in general – not to mention to develop a theory of life, which does not exist, as yet. Classically, viruses were explained as non-living organisms. Life presumably began with bacteria and archaea, namely with the classical distinction between prokaryote and eukaryote cells. Viruses needed a host to live, and it was the host that was conceived as a living organism. Viruses not being able to reproduce themselves were grasped as non-living organisms. Such was the traditional take on the issue.

However, it has come to be reckoned that there are more viruses on the biosphere than stars in the universe (Schulze-Makuch, 2020). Moreover, in contrast with what was typically thought, the air is not made up just with gazes. Rather, it is a highly complex com-

pound of organic entities, namely spores, viruses and bacteria (Prussin *et* al., 2015). Thus, most notably when a baby just born cries he or she fills his lungs literally with life, for in the womb of the mother in the midst of amniotic liquid he or she is protected against any possible infection. Air is literally full of life. Furthermore, viruses and bacteria literally fall from heaven for they are carried out from the clouds thanks to rains and winds, storms, volcanoes eruptions, hurricanes, typhoons and earthquakes. Life pervades every single second and place we find ourselves and makes up the highly complex weave of the biosphere. The Cartesian division between animated and unanimated matter is untenable in all senses. This observation could be extended to the cosmos; such an array however remains out of the scope of this paper[1].

Being as it might be, consciousness is not an epiphenomenon. Consequently, life is not a mere accident in the universe. Nonetheless, the framework of this study remains within the biosphere, i.e. the down the earth pole for the understanding of life.

This paper argues that such a pole is the unity of geology and microbiology, a distinction that – it should be highlighted, is just analytical or epistemological. The roots of life are to be found in microbiology, not just in the upper layers of life. Microbiology at large offers the most solid ground for the understanding of life (Margulis, Sagan, 1997). The outcome is magnificent: we live in a symbiotic planet (Margulis, 1999) whose roots are largely made up of the interplay between viruses, fungi and bacteria. In other words, there are not oppositions or distinctions within the realm of microbiology, but interconnectedness and entanglement.

It is such entanglement which is classically seen as life in the upper layers, from plants to humans. The truth, however, is that humans themselves, very much as animals and plants depend for their life and health on the dynamics of bacteria, fungi and viruses – at large.

In other words, without any odds, the body of nature is rooted and made up from microorganisms in their interdependence. The very notion of a body – for instance when talking about the human body, is just an abstraction of a much more highly complex reality. Rightly said, the body in general is an interface between an internal ecosystem and an external ecosystem. The microbiome can be said the condensed name for the internal ecosystem. Yet, it is already very well known that the microbiome changes every single day and that in a planet with around eight billion people there are not two equal microbiomes. The microbiome exists in a closed intertwining with the macrobiome.

In the same tenure, the external ecosystems are regulated by the interplay between geology and microbiology. The higher species, say animals and humans, are just the effects of the dynamics and interplay that take place already from the bottom-up. Highly complex

1 I have been working of this direction; cfr. Maldonado, C. E., (2018) "Quantum Physics and Consciousness: A (Strong) Defense of Panpsychism", en: *Trans/from/acao*, Edicao especial, Vol. 41, pp. 101-118; doi: http://dx.doi.org/10.1590/0101-3173.2018.v41esp.07.p101

effects, though. We are recently discovering that microorganisms play a most important role in the climate and weather phenomena (Tiedje *et al*., 2022; Cavicchioli *et al*., 2019).

In other words, given the environmental crisis that is going on and the probably upcoming environmental catastrophe, it would be sound to look at the importance of microorganisms, and not just to the importance of insects and forests. The weave of life cannot be rightly grasped dividing or separating frameworks, contexts, levels or dynamics. This is the crux of complexity science, indeed, namely thinking about, or also in terms, of synthesis. Not just any longer about analysis.

Nature is subtle – as wisdom has already made it clear in numerous times. Nature does not just speak openly and directly – which it does, indeed, as it happens. More frequently nature speaks in a variety of languages and modes usually subtle and with hues (Malin, 2001). Thus, very much as the concept of species is biased because it is extremely anthropocentric, so too is the notion of a body equivocal. The truth is that the body is made up of a multiplicity of stances, namely it is a system of systems, for example, the limbic system, the cardiovascular system, and many others; it is made up of human cells along with the presence and influence of viruses, bacteria and fungi, and some cases, prions do happen, and so on and so forth.

The body is thus just an abstraction or a generalization than sometimes ignores the complexities that lie underground.

Microbiology is the body of nature, but microbiology is the name for diversity, multiplicity, connectedness, interplay and entanglement.

3–. Evolution as the name for life

The theory of evolution is by and large the best theory ever developed about change, dynamics, transformation, processes. The trouble though is that it is an incomplete theory – something that was already reckoned by Darwin himself[2]. After all, both the universe and life are unfulfilled phenomena in process of continuous completion. However, the core of evolutionary processes are the inflections, ruptures, discontinuities of change. Gould and Eldredge explain evolution as punctuated equilibria (Gould and Eldredge, 1977; Gould, 2007). More exactly, living systems originate and exist in geological moments, i.e. thanks to geological processes, which are as it was mentioned above, catastrophic.

Evolution takes place in a twofold way, thus: vertically – by offspring and heredity, which is the typical Darwininan explanation, and horizontally – by learning and adaptation, which

2 Indeed, in the last paragraph of the Introduction to his book form 1959, Darwin writes: "No one ought to feel surprise at much remaining as yet unexplained in regard to the origin of species and varieties (…). I am fully convinced that species are not immutable (…). Furthermore, I am convinced that Natural Selection has been the main but not exclusive means of modification" (Darwin, 1995).

is the classical Lamarckian understanding (Buchanan, 2010). It has been recognized that the horizontal evolution happens much more quickly than the vertical one, accelerating the process of life on Earth.

In this sense, evolution reissues what geology and microbiology write. Geology and microbiology happen both vertically and horizontally (Sahu *et al*., 2023), and gene transfer finds more than one single way (Bethke *et al*., 2023). All in all, gene transfer is but one side of evolution, for the other side of the token consists in the environment – a wide open and undetermined concept.

A remark is needed in this point. Very much as it is compulsory to overcome Platonism in regard to cosmology – which is the wrong belief that we can view the universe from the outside, so too, Platonism must be absolutely overcome in the realm of biology. There is nothing outside evolution. Evolution is the proper name for both the universe and life. There are not living beings on the one hand, and evolution on the other. Evolution is the name for life. A sound understanding of complexity becomes hence after possible.

Evolution, albeit, does not consist just of changes and transformations, dynamics and movement. Evolution is – to bring together life and geology, a catastrophic event, a catastrophic process (Cuvier, 2009). As Gould and Eldredge brought it conveniently out evolution consists of inflections given several stasis, before and after each inflection (Gould, Eldredge, 1977). In other words, the story of evolution is exactly the story of ruptures, discontinuities, bifurcations and discreetness. Exactly the spirit and voice of complexity theory.

Life is indeed a game of unceasing exploration, defiance, challenge and audacity Jacob, 1986). Anthropocentric as it may sound, only those living beings that exhibit such characteristics are properly alive. In contrast, those who just follow inertia, remain passive or submissive, obedient and behave law-like can be said to be dead or to say the least, much less alive. Computationally speaking, the living beings are non-algorithmic. Voilà a most pointing recognition.

Surprisingly the story of life has begun a number of times. Given the presumable origin of life somehow, somewhere around 4.5 billion years ago the five mass extinctions that have taken place so far have at each time reset the entire tape of life. Particularly after each mass extinction life has arisen every time more robust and strong, more diverse and rich in any sense of the words (Leaky, 1996; Gould, 1990). Arguably evolution is all about novelty and change, creation and adaptation – certainly not about permanence and maintenance, endurance or stability.

The story of evolution consists in the arrow of time as an arrow of complexification (Lineweaver *et al*., 2013). Nature loves complexity, it appears. Complexity is the very process of becoming always more adaptive more capable of learning, in fact, more knowledgeable.

In other words, it is the history of life and knowledge becoming always more comprehensible and understandable. The roots, albeit, are to be found in microbiology at large and, thereafter, in the interplay between microbiology and geology – at the level of the biosphere.

Indeed, evolution begins much earlier than the living beings, and it does not stop with the human beings. Nonetheless, the game of evolution can be said in a twofold way, thus as the game of knowledge and the game of life. Such games are of the highest complexity imaginable. In other words, evolution poses the magnificent and yet surprising process of the rise and increase of complexity (Chaisson, 2001).

To be sure, complexity emerges locally in the universe whereas, at the same time, entropy increases overall. The story of the universe is the story of increasing complexity from the big bang to the creation of energy, from the shift to matter to the emergence of life and consciousness. Yet, at the same time, entropy increases overall as the universe evolves. The shift of ultraviolet, the red shift, the importance and meaning of pulsars and quasars, the significance and role of black holes, most notably are cases and phenomena that pose the importance of entropy. To be honest, the issue remains open – to ongoing research.

Nonetheless, it should be clear that evolution is triggered and led by contingency – randomness, chance, stochasticity. These are undoubtedly the most difficult epistemological, psychological and emotional challenges for a mindset formed by the ideas of necessity and law-like dynamics. The very universe, the story of life and evolution are one and the same thing. Plainly said, there is nothing outside the universe – even though the idea of multi-verses has recently arisen, very much as there is nothing outside evolution. The consequence pumps up immediately for a sensible imagination: life pervades what-there-is (das *Welltall*).

Probably the most surprising outcome of evolution is self-organization or also autopoeisis, namely acausal phenomena and systems.

Life emerges in the universe, of expresses itself in the midst of randomness and chance, entropy and disorder. Literally, we get order through fluctuations. Fluctuations seems to be the corner stone that unites geology, microbiology and evolution.

4–. Conclusions

The interplay between geology, microbiology and evolution constitutes an organic unique system. It is namely in the most immediate stance the uniqueness of the biosphere in the framework of the solar system – place and time, it appears, where presumably order is embodied at its best, so far.

In the probably arcane jargon of complexity science, there is a hidden order, and complexity theory conveys that hidden order and makes it visible. Life is a manifold and multiform experience, meaning that there is not a unique and exclusive way in which it is embodied.

In the horizon emerges the plausibility of finding new life and intelligence in the outer space. Or also, the possibility of discovering that life pervades the universe provided that we get to truly know what life is. A most compelling research program, as it happens.

Indeed, let us put it straightforwardly, thus: there are more than one hundred definitions of life, and yet none get truly the point. Life is a game that never ends neither starting nor finishing, it appears. Grasping the nature of life consists in reaching a theory of fundamental processes, which we do not have as yet, even though there are good hints around.

Geology is about processes, very much as microbiology are fantastic processes recently revealed by spearhead research. There are no clear-cut domains, but rather mingled, entangled, co-dependent processes that continuously create shapes and transform them unceasingly.

In the biosphere, microorganisms – from viruses to fungi, from bacteria to slime and protozoa, for instance, create and determine the temperature of niches, biomes and ecosystems. Unlike humans and big animals, microbiology can be safely said to be grand reservoir of life.

Viruses stand somewhere in the middle between animated matter and unanimated matter. They pose one of the most fantastic challenges for the understanding of life as we know it as well as it could be possible. Nothing must be taken for granted – definitely not when dealing with life at large.

In its origins, microbiology began as a unified science using the principles of chemistry to understand living systems. Very soon though, it split into the subdisciplines of medical microbiology, molecular biology, and environmental microbiology. According to Kolter (2021), the advent of a universal phylogeny and culture-independent approaches has helped tear down the boundaries separating the subdisciplines. The vision for the future is that the study of the fundamental roles of microbes in ecology and evolution will lead to an integrated biology with no boundary between microbiology and macrobiology. To be sure, the unification of microbiology and macrobiology finds in geology its most appropriate ground bringing a robust view of reality. Thus, an optimistic view of the interplay between the Earth and the universe emerges.

Knowledge and understanding are about being able to grasp both the commonness and the differences in levels, layers, contexts and frames. Geology and microbiology are the voice and the body of nature, correspondingly. We have seen them in this paper as the down to earth pole of life.

The scope here is the biosphere, but just for the sake of framing the voice and the body in a direct experience. In other words, the delimitation has been only epistemological, for it should be clear that the biosphere offers a most basic terrain for grasping the complexity of life, namely life as-we-know-it very much as life-as-it-could-be-possible. Evolution can adequately be grasped as the name for life. The issue in any case consists in viewing and understanding processes, change, transformations.

History, culture and everyday life (*Lebenswelt*) is what happens when nature allows them. Geology cannot be taken for granted. Apparently, the most enthralling processes in and of the human beings are in and the outcome of symbiosis, holobiontic dynamics, wonderful ecological systems in and around the human beings. Paraphrasing C. Rovelli, reality is not what it seems (cfr. Rovelli, 2018).

The morals of this paper claims that we should be able to view nature as the rationale for history, culture and everyday life. Nature must not and cannot be taken for granted. Geology has the merit of bringing together physics, chemistry and biology. Microbiology opens up the gate for viewing the vast array of life, down-there.

However, as Heraclitus liked to say, the road up and the road down is the same. Plainly said, as above, so below. If so, the down to earth pole of the understanding of the complexity of life suggests implicit and indirect lights on to the upper pole. This upper pole, notwithstanding, should be the subject of a different paper.

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