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Animated Machines, Organic Souls: Maturana and Aristotle on the Nature of Life

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Abstract: **The emergence of mind is a central issue in cognitive philosophy. The main working assumption of the present paper is that several important insights in answering this question might be provided by the nature of life itself. It is in this line of thinking that this paper compares two major philosophical conceptualizations of the living in the history of theoretical biology, namely those of Maturana and Aristotle. The present paper shows how both thinkers describe the most fundamental properties of the living as autonomous sustenance. The paper also shows how these theoretical insights might have a consequence upon our understanding of a specific constructiveness of human cognition, here referred to as enarrativity, if this can be considered in a structural as well as evolutionary connection with the structure of life as such. The paper finally suggests that the structural connection made here can be traced from the fundamental organization of self-preservation to survival behaviors to constructive orientation and action.**

Keywords: **autopoiesis, soul, system theory, organism, cognitive philosophy, enarrativity, theoretical biology.**

I. INTRODUCTION

Although life is a condition for minded organisms, the reverse is not implied. The opposite direction remains excluded: not all living beings are minded, not even in any incipient form. Some philosophers of biology opt for positing the mental as a given in some incipient form in the quandary of explaining the emergence of mind in living beings. I do not agree with this view, which is exemplarily articulated as the Incipient Mind Argument by Evan Thompson [1], because it works with a non-secular understanding of nature (i.e. metaphysical, subjectivist) and because it simply overlooks important biological basic facts. Edelman [2], for example, emphasizes not only that the development of a nervous system is one sine qua non condition for the mental, but also that the presence of nerve cells alone is not a sufficient condition for it. According to Edelman [2], living beings might be able to develop a mental sphere only in conjunction with the development of a specific (neural) morphology. Álvarez-Vázquez [3] has discussed the issue of the Incipient Mind Argument, showing that the argument fails to provide a secular and non-metaphysical explanation in great part because it still adheres to the subjectivist logic of the past. For now, it is important to take a look to the fundamental properties of the living being in order to show how the connection between the biological organization and the different forms of knowledge employing the cognitive skill of "enarrativity" should be understood (in Álvarez-Vázquez's [4] sense), namely the particular constructive ability that the human mind employs in order to understand its lived-world oriented existence.

In this paper, I argue that one of the most important characteristics of living beings is the capacity to preserve or conserve themselves. This observation is by no means a new insight in theoretical biology. Already in the early 1970s, a small group of biologists and information scientists at the University of Chile in Santiago, developed a theoretical description of the living being. They defined the central capacity of self-preservation as a specific organization and they named it *autopoiesis*. Concerning humans' cognitive ability of reconstructing states of affairs in the field of objects and events, it is important to understand self-preservation as a specific form of organization. This understanding is crucial because as life evolves to more complex organisms the organization of self-preservation, respectively of survival arrangements, gradually

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drops off from its primeval genetic fixation. And so, the behavior of mobile species is intrinsically connected with the fundamental characteristic of self-preservation that characterizes all living beings. Although even complex forms of behavior can be trace down to genetic fixations, the drive for self-preservation is no longer limited to the organismic body. Rather, it goes beyond the bodily boundaries gaining a wider dimension in space and time within the environmental sphere. This is the new dimension brought about through self-motion that we might call here the enactive dimension. And so, the self-preservation capacity of living things becomes behaviorally enactive.

The enactive dimension of self-preservation has its roots in the capacity of motion, and, in the case of mammals, in the organismic capacity to self-localize and to navigate within the organism's direct environment. In this vein, I shall conclude this paper by making reference to a hypothesis, which suggests that enactive self-preservation (initially) would have to couple with spatial orientation. I will call this *the orientation thesis*. I shall not develop the orientation thesis here because it would go far beyond the scope of the present paper. Nevertheless, it is important to have it in perspective for the relevance and impact of the present research.

II. LIFE, AUTOPOIESIS, AND SELF-PRESERVATION

All biological forms of life are systems that show in normal conditions at least the following four characteristics: (1) energy exchange and energy conversion[1] (such as photosynthesis and the breakdown of nutrients), (2) exchange of chemical substances (for example, the exchanges comprised in metabolism), (3) processing of stimuli (for example, through perception), and (4) growth (including development and maturation). A living system performs all of these processes *autonomously*, and always in interaction with the environment. In addition to these fundamental characteristics, almost all known forms of life have the tendency to reproduce and to adapt themselves to the environment. And many of the living beings we know are mobile species (motion).

Maturana and Varela [7] define the living organism by means of its fundamental organization. Humberto Maturana, assisted by Francisco Varela and José Bulnes, called that basic organization *autopoiesis* [8]. The autopoietic understanding of living systems mostly concentrates on the resulting organization from the first two characteristics mentioned above: (1) the exchange and conversion of energy, and (2) the exchange of chemical substances. A concise comparison between Maturana's conceptualization of living systems and the Aristotelian formal analysis of living beings will contribute to better understand life in its organismic context. Aristotle distinguishes a fundamental subfaculty of the nutritive capacity of the living being, describing it as self-preservation. I suggest in this chapter that the similarity between the Aristotelian distinction of self-preservation and Maturana's understanding of autopoiesis is greater than their contrasting aspects. Understanding the convergence between Aristotle and Maturana also might provide some evidence for arguing that Maturana's mechanistic framework is by no means necessary in order to grasp the self-preserving property of living organisms.

It is important to briefly depict here how Maturana (and Varela)[2] has seen the theoretical situation in biology at the time he developed his concept. The importance of Maturana's appreciation of that situation is that it provides one of the possible explanations for his theoretical modus operandi. Maturana outlined the precarious situation of theoretical biology in the early 1970s. He argued that even though biology has made enormous progress in its manipulative and dissecting character as an experimental science,[3] biologists were dissatisfied with the theoretical achievements so far. Maturana reported this in the following way:

> Apparently we are at a point in the history of biology where the basic difficulties have been removed. Biologists, however, are uncomfortable [*desalentados*] when they look at the phenomenology of living systems as a whole. Many manifest this discomfort by refusing to say what a living system is. Others attempt to encompass present ideas

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[1] For an insightful and accessible description of how living cells derive their energy and how they conserve it in terms of the biological energy transduction in the case of cellular respiratory chains, see [5], pp. 56-73. For a more technical and philosophical discussion, see also [6].

[2] Humberto Maturana formulates the main ideas of the autopoietic organization of living organism around 1969, three years earlier to the publication of *De máquinas y seres vivos* in 1972. He is also the one who suggested the word "autopoiesis" for the description of the specific organization of living beings (see [8], pp. xvi-xviii). For practical reasons, I shall subsequently mention just Maturana even though I mean both authors.

[3] For a useful taxonomy of the different sciences, see [9].

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> under comprehensive theories governed by organizing notions, like cybernetic principles, that [implicitly, *implícitamente*] require from the biologists the very understanding that they want to provide. ([7], p. 11; [10], p. 74)[4]

Vitalism, the view that living organisms are fundamentally determined by a non-physical, vital principle or force (*spiritus seminalis*, *impetus faciens*, *vis vitalis* and *élan vital*, among other terms), seems to be completely obsolete for the modern biology, while Darwinian evolutionism harmonizes with chemico-physical approaches, such as in molecular biology. Nevertheless, there is a lack of a general framework for an understanding of the living. And since more than a few vitalists appeal to Aristotle to sustain their conjectures, Maturana thinks that Aristotle himself postulates such a vital principle. In other words, Maturana passively assimilates a very specific effective-history of a vitalist approach to Aristotle. This might be one of the fundamental reasons why Maturana fails to hit upon the similarities between his concept of autopoiesis and the Aristotelian one of self-preservation.

But more important than the subjectivist *why* are these two concepts comparable is the objectivist *how* they actually compare to each other. So, let us start with the modern concept of autopoiesis and then go back in time to the Aristotelian one of self-preservation in order to point out the conceptual similarities.

III. AUTOPOIESIS AND ORGANIZATION: THE BIOLOGICAL ARRANGEMENT OF LIFE

Maturana refers to living organisms as a kind of machines. This description might sound awkward to the modern reader. However, it can be tolerated, insofar as we understand the context of its formulation. Although Maturana abandons the use of the machine-metaphor in the next collective Works *Autopoiesis: The Organization of Living Systems, Its Characterization and a Model* [12], published in 1974, and *El árbol del conocimiento* [13] originally published in 1984 (translated into English as *The Tree of Knowledge* [14] in 1987), the machine-metaphor takes a central role in *De máquinas y seres vivos* [7], originally published in 1972 (*Autopoiesis: The Organization of the Living* [10]). Presumably, Maturana and Verela opt for this metaphor in order to disassociate themselves from other approaches that resort to metaphysical principles that are alien to the physical world. By employing the machine-metaphor, they are, in other words, taking a materialist position:

> Our approach will be mechanistic: no forces or principles will be adduced which are not found in the physical universe. Yet, our problem is the living organization and therefore our interest will not be in properties of components, but in processes and relations between processes realized through components. ([7], p. 12; [10], p. 75; see also [12])

Although the general system theory ([15]; [16]) as such has its origins in biology, it is through cybernetics that Maturana and Varela encounter the systemic approach. Consequently, they did not have a third option available like the one represented by the developmental system theory that nowadays is gaining ground in theoretical biology, as well as in the philosophical debate ([17]; [18]; for a historical review see also [19]). The developmental system theory puts forward a macro-perspective that aims to integrate genetics, developmental biology, and evolution. It tries to surmount, thereby, theoretical difficulties caused by an underlying linear thinking that is backed by dichotomous models and a genocentric causal understanding of development, as well as of evolution [20]. For the purpose of the present paper, the lack of a third option means that for Maturana and Varela there are still only two major possibilities for explaining the phenomenon of living systems, namely vitalism and mechanism. The closest alternative for their theoretical understanding of living systems is thus certainly mechanism, since vitalism, the view that a non-material living force rules and governs the living organism, has become obsolete in contemporary theoretical biology ([7], p. 10; [10], p. 74). Accordingly, living organisms were conceptualized as a kind of machine describable in terms of physicochemical and organizing processes. However, although the mechanist framework forms Maturana's starting-point, we shall see how his insights develop toward a germinal system theory of the living.

But what kind of machines are living organisms? Notice that Maturana's answer to this question is far from being a pure physical description neither of the components nor of the specific functions of the machine, as he already indicates in the quotation above. His central concern is the organization per se, as he learned from the computational systemic approach:

[4] I am quoting the English version of *De Máquinas y Seres Vivos. Una teoría sobre la organización biológica* that was published in Maturana and Varela 1980 [11] for practical reasons. Nevertheless, my discussion is based upon the original Spanish version of 1972 [7]. In some cases, I will amend the quotations by providing the original Spanish word next to its English equivalent or adding some omitted words in brackets for the quotations or in parentheses in the text. Both here and subsequently, the references given are of both versions.

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> Autopoietic machines are homeostatic machines. […] *An autopoietic machine is a machine organized (defined as a unity) as a network* [*sistema*] *of processes of production (transformation and destruction) of components that produces the components which: (i) through their interactions and transformations continuously regenerate and realize the network of processes (relations) that produced them; and (ii) constitute it (the machine) as a concrete unity in the space in which they (the components) exist by specifying the topological domain of its realization as such a network.* ([10], p. 78-79; [7], p. 18)

With the aim of providing a general definition of the living, the main idea is a systemic and a processual one. The living organism is conceptualized as a system of relations sustained by its processes themselves. As soon as the processes cease, the established relations start to break up, having the consequence that the repairing network splits. The organism thus fails to sustain itself, ending in decay. Notice that this conceptualization of the disarrangement of the autonomous conservation may also be understood as a gradual process that might almost certainly go along with life itself and is closely related to senescence. Maturana and Varela ([10], p. 79) have this processual networking in mind when they emphasize, regarding the autopoietic system, that "since the relations of production of components are given only as processes, if the processes stop, the relations of productions vanish." Therefore, "for a machine to be autopoietic", Maturana and Varela underline, "its defining relations of production must be continuously regenerated by the components which they produce." For the intended comparison with Aristotle's conception, I would like to stress two fundamental aspects of the autopoietic organization, namely the aspect of self-preservation or self-conservation and the aspect of autonomy as already implied in the first.

Self-preservation and autonomy characterize, therefore, the autopoietic organization. Taking in consideration that Maturana's approach to living organisms is a computational systemic one, his description of them in terms of relations, processes, and of organizing features seems to be completely concordant and consequent. Accordingly, self-preservation and autonomy also mean that autopoietic systems organize themselves in a relative higher autonomous manner. And precisely this systemic and organizational twist in these reflections is one of the most important legacies from the seminal works of Maturana and Varela ([7]; [13]). Within the systemic framework, autopoietic organisms are thus, by all accounts, self-organizing systems.

With respect to the faculty of self-preservation, Maturana and Varela ([14], p. 43; [13], p. 25) underline that it consists in a continuous process of repairing parts, of exchanging constitutive elements, so that preservation is achieved through the constant production of the organic structure as a whole. They suggest, consequently, "that living beings are characterized in that, literally, they are continually self-producing." This processual understanding is, indeed, seriously meant, when they employ the term *autopoietic organization*, as the quotation above continues: "We indicate this process when we call the organization that defines them an *autopoietic organization*." And so, from the systemic point of view, self-preservation inextricably leads to the fundamental aspect of autonomy.

Autonomy is for Maturana and Varela ([14], p. 46-47; [13], p. 28) not just a fundamental aspect, but also the most prominent one that living beings show. Then, after all, it is through the observation of the autonomous organization that one firstly tends to identify some specific system as a living thing. In this connection, our authors do not hesitate to show their fascination for this central characteristic. With respect to autonomy, they consider that the "most striking feature of an autopoietic system is that it pulls itself up by its own bootstraps and becomes distinct from its environment through its own dynamics, in such a way that both things are inseparable." The two things they are talking about in the quotation's context are the autonomous dynamic of structural maintenance, on one hand, and the constitutive boundary that enables the organism to differentiate itself as a recognizable entity within the environment, on the other hand. But we do not want to get there yet. I shall discuss this last aspect under the topic of bodily boundary and positionality somewhere else. For the current discussion we just need to concentrate our attention in the aspect of autonomy. Autonomy is certainly not an exclusive characteristic of living beings alone, and Maturana and Varela ([14]; [13]) recognize this. But the organism's capacity of autonomously organizing, as well as of continuously arranging the organismal structure in order to keep alive and, by extension, to survive as a differentiable entity, contrasting with the environment (including other individuals), is certainly the generic case of living beings. It is precisely the conjunction of these two aspects that forms the living being.

Anticipating an ancient misunderstanding, however, these two aspects are never to be found as separate, not even as separable in real, phenomenal life. Self-preservation and autonomy in living beings are only separable in the mind of the

observer. Due to this, one may linguistically refer to them as two distinct aspects of one and the same phenomenon. Nevertheless, they do not exist as two separate things in any given living organism in time and space. For this reason, it is always convenient in philosophical reflections to beware of confounding categorial distinctions (ontological) with real existent phenomena (ontic).

However, one might always find extreme cases in biology, where it is not clear whether it is about life, death, or a transitional phase. The emergency modus (cryptobiosis) of most terrestrial tardigrades, the so-called *Wasserbärchen* (little water bear, in German), can serve as a remarkable example for an extreme case. These tiny creatures look like a kind of eight-legged bear with a body length from around 0.1 mm (0.0039 in) to 1.2 mm (0.047 in). They live all around the world in biotopes with abundant fresh water like mosses with spring water. In order to survive to temperatures as high as +150 °C (+302°F) and as low as −270 °C (−454 °F), for instance, these creatures switch to a kind of static preservation modus called cryptobiosis, in which all metabolic processes seem to halt for relatively long periods (e.g. as long as 20 months at −200 °C). The processes needed for self-preserving apparently stop. But like in many other extreme cases, the problem often relies more on our accessibility to the phenomenon in question, rather than on a discovery of a factual exception. The term crypto-biosis itself suggests this construal, since "cryptós" (κρυπτός), the Greek word for "hidden", "unintelligible", points out the inaccessibility of the observer to see or to understand what is behind that state of life. In any case, exceptions in particular are located outside the target and beyond the goals of generalizing conceptualizations. In the case of our tiny bears, biologists say that there is just no measurable evidence for affirming any metabolism. However, the cryptobiosis or ametabolic state of tardigrades seems not to represent a problem for our current discussion, since the aspects of self-preservation and autonomy remain untouched insofar both aspects become at once hidden and inaccessible to our observation. The real challenge would rely rather on the aspect of the processual continuity, inquiring whether or not it is about an interruption or a kind of suspension in the organismal cycle. Further studies toward the aspect of a requisite continuity in the living systems would certainly be very welcomed. But for now, even our tiny bears still show the typical and fundamental characteristics of self-preservation and autonomy in their active state, corresponding their normal species-specific lifeway ([21]; [22]).

As ordinary cohabitants of our Earth, tardigrades feed on things like aquatic plants (algae), particles of mosses and liverworts (bryophytes), single-celled microscopic animals (protozoa) of different kinds, and even roundworms (nematodes), just to mention some aspects of their diet. This kind of nourishment is, to some extent, necessary in order to sustain their body, which is quite elaborated for an invertebrate. The tardigrade's body consists of a brain, a multiplex structured feeding apparatus connecting to an alimentary tract, sensory organs, muscles, regulatory organs for the constant maintenance of the osmic pressure, and reproductive organs [21]. They come into existence by hatching from eggs, they grow, and, after a while, the also die; although they have a relative long lifespan under normal conditions (active state), considering that they are small metazoans (ecdysozoans). In the active state, these microscopic bears live from approximately 3 to 5 months up to 18 to 30 months, depending on the species [23]. In the course of their lifespan, in the fashion of actual living beings, they show a complex of the processes of self-nourishment, that is to say self-sustenance, as well as of development and growth. But, though this might sound counterintuitive, they also manifest the process of passing away. Then, to be able to die, as I shall further argue, is an integral aspect of life, common to all living beings.

Be it a single-celled organism such as a paramecium, a metazoan of the tardigrada phylum such as a limno-terrestrial water bear, or even a higher mammal as a chimpanzee, all these animals show the two most fundamental characteristics of being alive, just as the rest of the kingdoms of life like plants and fungi, for example. According to Maturana and Varela, self-preservation and autonomy are the two pillars in conceptualizing the living being as an autopoietic organization.

Importantly, that living beings show the fundamental characteristic of self-preservation, for instance, is not Maturana's achievement in the history of the theoretical understanding of the living. Maturana's accomplishment relies rather in making the conceptualization of the organism as a systemic organization a topic of discussion once more. The autopoietic organization that consistently organizes and rearranges itself in a systemic manner has since then constituted a very productive approach in many fields, including sociology (e.g. [24]). Also for our narrative Maturana's conceptualization of the living being as a specific kind of organization proves advantageous for at least two reasons. Firstly, the term "organization" and its derivatives enable us to refer to the concrete material, physical elements of an organism and, simultaneously, to the relations between them. Secondly, it also makes possible accurate descriptions of organismic processes, as well as of the interactions within its environment in systemic terms on a meta-level. The point I am trying to

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make clear here is that relations and organizations, as well as the processes described in those terms, are constructions of understanding about the empirical world. The observer thus makes these constructions, albeit not in an indiscriminate fashion. And this is the way the constructive realism works on the ontogenetic level, as well as in scientific conceptualizations. But in order to move on to the introduced comparison with Aristotle the guiding question is the following: to what extent does Maturana coincide with the alleged ancient vitalist?

IV. THE ARISTOTELIAN CONCEPT OF STRUCTURE (*entelécheia*)

Aristotle's innovative conceptualization of the living proves itself to have been quite unsuccessful in the Western history of thought, since our understanding of the living and, in particular, of the human life was still to be traced back to Plato until fairly recently. But in the current debate on the cognitive skills of animals between a neuro-centrism and the contemporary embodiment or enactivism ([25]; [26] und [27]), Aristotle has been called upon for historical reference. And the allusions to Aristotle are, of course, not by chance.

Aristotle was also, mutatis mutandis, between two fronts with respect to the concept of the living. Ancient Greek philosophers, indeed, thought of the aspects of life in terms of an entity. They thought that living beings possess something invisible or even immaterial that makes them work and interact. They called that entity soul. And so, the Platonic soul-body dualism (later developed as the mind-body problem) stood on the one hand, and the reductionist materialism of the pre-Socratic natural philosophers on the other. While Plato and the Old Academy held the view that the soul belongs to a kind of intelligible, eternal sphere and, consequently, that it survives the body's death, the natural philosophers defended several variants of the thesis that the soul consists in one or more of what were then considered fundamental elements, such as earth, water, fire, and air. Contrasting with these contrary positions among others in the context of the fourth century BC ancient philosophy, Aristotle develops a radically new conceptualization of the soul.

Unfortunately, Aristotle adopts the term *psychḗ* (ψυχή, traditionally translated as soul), yet he extends its content to the living as such. I say unfortunately, because the term *psychḗ* had developed from the Homeric epics (approx. end of eighth century BC) to the second half of the fifth century BC from denoting the "breath of life", for example, to generally designating the personality of the human individual. In addition to this, as Flashar [28] explains, it already had moral connotations by the time Aristotle adopted it. *Psychḗ* was thus considered as the "organon" of human apperceptions, emotions, and of thinking in general. Keeping this historical background in mind, I regret Aristotle's assimilation of the term *psychḗ* because his radical innovation reaches so far that it would have deserved a new linguistic expression.

The Aristotelian innovation in the reflections of the *psychḗ* consists in overcoming both dualism and reductive materialism by taking the observational position of a natural researcher ([29] = De an. II, 403a 28-30) and treating *psychḗ* as a categorial tool, in order to conceptually grasp what differentiates the living body from the non-living one. Consequently, *psychḗ* works as the principle, that is to say the *formal concept* of the living in general. And as such, *psychḗ* makes explicit the structure of the living body (De an. II, 412b 4-6). Note that I am translating here the Greek word *entelécheia* (ἐντελέχεια, from ἐν [ἑαυτῷ] τέλος ἔχειν, following von Fritz [30]) as "structure", which means "that what has its end in itself". I suggest this compressing translation, since having an aim or a plan in oneself might also mean that the being in question is organized in such a way, so that the organization itself constitutes its specific structure of being. In contrast to what Blair [31] proposes, the end or aim (*télos*, τέλος) is not to be localized somewhere *inside of*, say, a paramecium, but rather *throughout* its body and behavior *as a whole*. No *télos* inhabits a living body, but instead the *télos* shows up for us in our observation of the bodily and behavioral arrangement as such. If *télos* means "end" in the sense of an aim or a plan, then for a paramecium having a plan in itself might point to the relation of the cilia (the small hair-like organelles along the membrane) with the locomotion of the whole organism, or the lipid arrangement of the plasma membrane in connection with the contractile and food vacuoles organization, for example. In this sense, an actual specific structure is just as inherent to the living body as a plan does to any systemic organization. And this is exactly what Aristotle is doing when he employs his neologism *entelécheia*, often fluctuating between the substantive and adverbial functions (cf. von Fritz [30]). Thereby, Aristotle comprises the complex bodily and behavioral relation of being-organized-toward-a-plan into a linguistic-semantic construct that can be objectivized as if it were a thing: namely, the *entelécheia* or structure. In the case of the *psychḗ*, *entelécheia* refers, indeed, to the specific dynamic structure of self-organizing systems that (autonomously!) preserves themselves. Yet, this definition of *psychḗ* as the structure of the living body is just a preliminary one. It communicates an important starting-point to us, though it consists of two aspects. Firstly,

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living bodies, that is to say living beings, have a particular structure. And secondly, that structure is inherent, intrinsic, and thus constitutive to them. A more detailed inspection of Aristotle's concept of *psychḗ*, that is to say the structure of living beings, will show how close Maturana and Aristotle are to each other, especially concerning the fundamental activity of self-preservation.

I am proposing here a relative modern reading of Aristotle's understanding of the living being. Aristotle does not discuss the *psychḗ* as a real entity, but rather as the formal conceptualization or a categorization of the *observed* living being, as Shields [32] and Corcilius [33] also suggest. What is given in the world is the living being as such. *Psychḗ*, on the contrary, is just the constructed concept for the formal understanding of the living. Notice that Aristotle literally refers to the *psychḗ* in the sense of a category (*katá ton lógon*, κατὰ τὸν λόγον), although his narrative occasionally evokes the impression of being quite fickle on this aspect (De an. 412b 10-11). Furthermore, it is important to keep in mind a historical factor of Aristotle's production that has given trouble for the interpretation of his texts, especially of his *On the Soul* (*De anima*), which we are now dealing with.

Aristotle is situated just before the threshold that leads to the historical understanding of the convergence point between the conceptual knowledge of the world and human constructiveness. Importantly, although there is already an understanding of the convergence point between the structure of the society and human agency in general, indicated in the development of the Greek polis in the late eighth century BC [34], the further abstract reflection upon the convergence point concerning knowledge acquisition had to wait until modernity in the mid-sixteenth century. This phenomenon is known in the humanities as the "consciousness of convergence and constructiveness of the world" [35] on the one hand, as well as the "anthropic principle" [36] on the other. Note that the label suggested by Welsch [36] might lead to confusions with the similar term in astrophysics. Whereas "convergence" means that the world in its formation, organization, and understanding moves closer to the human subject, "constructiveness" signifies that the subject itself constructs and construes the world, as well as the ways of action within its milieu. Applied to Aristotle, what this means for us is that he has considerable trouble in *consistently* differentiating between the conceptualization of a being and the constructive process toward the conceptualization as such. And this, I suggest, is why Aristotle's narrative frequently seems to fall back to referring to the *psychḗ* as if it were an entity that living beings might have or be inhabited by. Notwithstanding these problems, Aristotle is unambiguous and quite perspicuous at the very beginning of Book II of his treatise *On the Soul*, where he exposes his project concerning the formal analysis of the living being, using his hylomorphistic strategy in conjunction with the term *psychḗ* as a compound category ([37]; [38]).

In contrast to the elaborated analysis of the living by means of the concept of *psychḗ*, Aristotle's general understanding of life as such is astonishingly simple. He calls life (*zoḗ*, ζωή) the nexus of the processes of the autonomous (*autou*, αὐτοῦ) nourishing (*trophḗ*, τροφή), growth (*auxēsis*, αὔξησις), and finally decay (*phthísis*, φθίσις) (De an. 412a 13-15). And so, his enterprise as a philosopher of nature is to investigate how these general processes of life are instantiated in the different forms of life, such as in plants (*phytón*, φυτόν), animals (*thēríon*, θηρίον), and humans (*ánthrōpos*, ἄνθρωπος) (De an. 414b 31-34). It is precisely in the most fundamental of these processes of life that we can find the theoretical convergence between Maturana and Aristotle, namely in the fundamental characteristic of energy exchange, energy transformation, and the exchange of nutritive substances. In accordance with this fundamental process of life, it is hardly surprisingly that Aristotle considers nourishing (*threptikón*, θρεπτικόν) the most primitive instantiation of *psychḗ*, that is to say, the most basic structure of the living body. Since Aristotle does not discuss the general processes of life in abstracto, we need to see how he concretely describes it as a specific instantiation of *psychḗ* in living beings.

V. SELF-PRESERVATION (*sōzein*) AND ITS LIMIT: LIFE AS FINITUDE

Aristotle calls the major activities of the living all together the "capacities of the *psychḗ*" (*dynameōs tēs psychḗs*, δυνάμεως τῆς ψυχῆς). He employs the term "nourishing" (*threptikón*, θρεπτικόν)[5] for the capacity in general. Concerning this capacity, he says that it is the only capacity that is common to all forms of life, since it is the "most fundamental" and the "most general" of them. And, moreover, it is because of this capacity that all living beings can be considered to be alive (De an. 415a 23-26). He repeats this assertion in other words in one of the concluding chapters of Book III of his treatise, summarizing it as follows:

[5] Whereby *trophḗ* may denote all three meanings, namely nourishing (capacity), nutrition (activity), and nourishment (object of the activity), depending on the context and uses. See [39], pp. 200-222.

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> Every being that lives necessarily has the nutritive *psychḗ*, and such a being has it from its coming into existence to its passing away. Then what has been brought into being necessarily has growth, maturity, and decay. Without nourishment these things are impossible. Therefore, the nutritive capacity is necessarily there in all things that grow and decay. (De an. 434a 22-24)

Yet, what is behind this capacity? As the quotation above suggests, the whole development of the organism depends on nourishing. According to Aristotle, nourishing consists in the fulfilling of a series of enactments or operations. These are divided into two categories. On the one hand, we have the enactments concerning the nutritive (*threptikḗ*, θρεπτικὴ) aspect, on the other the operations regarding the generative (*gennētikḗ*, γεννητική) aspect (De an. 416a 19-20). The nutritive encompasses the processes of digestion (*pépsis*, πέψις; also *trophḗ chrēsthai*, τροφῇ χρῆσθαι) and growth (*áuxēsis*, αὔξησις). He also refers to this specific activity (*érgon*, ἔργον) as the ability of "availing oneself of nourishment" (*trophḗ chrêsthai*, τροφῇ χρῆσθαι) (De an. 415a 26). In contrast, the generative aspect includes the processes of reproduction in the sense of the generation of another being of the same species (*tó poiḗsai héteron*, τὸ ποιῆσαι ἕτερον / *genéseōs poiētikón,* γενέσεως ποιητικὸν / *hē ... psychḗ gennētikḗ hoion autó*, ἡ … ψυχὴ γεννητικὴ οἷον αὐτό)[6] and self-preservation (*sṓzein*, σώζειν). Some of these processes are more fundamental than others. In the nutritive category, digestion of nourishment (*trophḗ*) is, for instance, more fundamental than growth. Concerning the question of what is essential and accidental to nutrition, Aristotle's words are more sophisticated than mine in referring to the object of nourishing:

> But being nourishment and a means of growth are [two] distinct [aspects]. Insofar as [the living] is something quantitative [as a living body], [the object of nutrition] performs as a means of growth; insofar as [the living] is something specific and a quality [as a living qua living], [the object of nutrition] occurs as nourishment. (De an. 416b 11-13)

Similarly, among the generative processes, self-preservation is a basic requirement for the individual organism reproducing and bringing an offspring into being. Since it is precisely there where we find the point of convergence between Aristotle and Maturana, I would like to focus our discussion on this last organismal mechanism of self-preservation.

Self-preservation (*sōzein*) is the most basic structure of life, since an organism, say a cat, might not give birth but still alive. Its condition of being sterile, for instance, would not impede it from living. From the two fundamental activities (*érga,* ἔργα) of the generative aspect, we thus might say that reproduction (in the sense of the generation of another being of the same species) is characteristic, but not essential to life, while self-preservation is a sine qua non to life as such, insofar as it is the organismal mechanism of an individual of "saving" itself, that is to say of keeping itself alive (Cf. [39], pp. 217-222.). Aristotle also refers to this difference between reproduction and self-preservation, pointing that an organism cannot reproduce itself in its sameness (as numeric identical), occupying another place in time and space. Rather, what an organism generates through reproduction is another member of its species. In contrast to the activity of reproduction, Aristotle formulates self-preservation with the purpose of describing the natural phenomenon, through which an organism preserves itself by itself through nourishment. He says:

> [Nourishment] also preserves the essence and this continues to exist, so long as it is nourished. Additionally, [nourishment] is also productive concerning the generation not of that, which is nourished, but rather of [another] similar to the nourished; *since its actual essence already exists. And nothing can bring into being itself, but merely preserves* [*itself*]. (De an. 416b 14-17; my emphasis)

But self-preservation as an activity needs energy to work. And it is in this sense that self-preservation depends on nourishment as the food, which provides it with the necessary energy to enact. In Aristotle words: "Nourishment sets the capacity ready to work" (*paraskeuázei energéin*, παρασκευάζει ἐνεργεῖν; De an. 416b 19). No doubt this dependence is a causal one. But it brings also into light that an organism is a system even in its fundamental organization. So, we modern readers might understand the particular Aristotelian method of starting the analysis of the capacity with its object and then with the particular activities as well as with the relations between them as a systemic account of the dynamic processes involved in the basic structure of the living. The mentioned dependence establishes, indeed, a systemic codependence, where the observable effectivity of nourishing is to preserve (*sōzein*) the organism (De an. 416b 18). We nowadays know that what Aristotle is describing, when he says that the nourishment changes (*metabállein*, μεταβάλλειν) and suffers

[6] See, for example, De an. 415a 28, 416b 15-16, and 416b 24-25.

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alteration (*metabolḗ*, μεταβολὴ) in the process of being digested (*péttesthai*, πέττεσθαι), is nothing other than one of the basic processes, through which energy exchange, energy conversion, and the exchange of chemical substances takes place in living beings, namely metabolism (De an. 416a 33-416b 11). Although in modern biology these processes are considered bruta facta, it was not the case at all in ancient Greece. But the advantage of mentioning Aristotle in this analysis is that he, in contrast to the abstract concept of organization, emphasizes the autonomous process of preservation as the most fundamental effect in the whole dynamic of nourishing.

There is no living being without the enactment of self-preservation. Both Aristotle and Maturana coincide in this point. For Aristotle self-preservation is so essential so that he articulates it, in an intrinsic connection with digestion, as the sine qua non activity of being alive. Further, he formulates it embedded within the capacity of nourishing as the only one fundamental and common to all living beings. As the minimum requirement for all living beings qua living, it might work as a definition. But Aristotle never formulated it explicitly in that way. Fortunately, Maturana made that step. Similar to Aristotle, Maturana also conceptually grasped the processes, by which the organism generates and replaces the elements and parts of its own organization in order to preserve the organismal structure of being alive, as the most fundamental characteristic of the living being as such. The concept of self-preservation, as Aristotle employs it, and the concept of autopoiesis, as Maturana formulates it, thus, converge in the fundamentality, the autonomous dynamicity, and in the reference to the particular system or structure of what is to be a living being.

Taking stock of the comparison between Maturana and Aristotle, life as instantiated in concrete organisms has one basic structure. According to Aristotle, we have seen that all forms of life share the same basic dynamic of autonomously keeping itself alive. Maturana conceptualizes this "keeping itself alive" as the self-standing maintenance of the proper organization of life. Yet, this seems to be quite circular. Indeed, Maturana ([39], p. 47) himself says that "the living organization is a circular organization" and that that organization is arranged in such a manner that the dynamics involved in it result in the preservation of "the very same organization" that causes them (see Figure 1). The basic structure of life common to all living beings consists, therefore, in the dynamic organization of self-preservation.

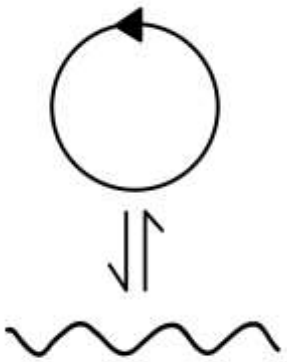

FIGURE 1: ***The autopoietic organization*** **(according to Maturana and Varela 1987/1998)**

This understanding of the basic structure of life is fundamental to giving an account of the mind's specific constructiveness of making the lived world comprehensible (enarrativity), because the structure of life builds the conceptual basis for the understanding of the evolution of behavior and the development of skills in living beings. The organismal mechanism of self-preservation at the micro-level extrapolates its structure in the organismic mechanism at the macro-level by means of survival behaviors. My suggestion is, hence, that all survival behaviors in animal life are structurally supported by the basic structure of life depicted above. And so, many skills, say cognitive skills, develop in conjunction with the evolution of behavior within the framework of interactions with the species-specific environment. Elsewhere, I will suggest that enarrativity is one of the most modern and sophisticated cognitive skills that have been developed in the course of human evolution. But before we get there, I would like to briefly summarize the insights developed here in conjunction with the orientation thesis, which might serve as the conceptual link that connects basic survival behaviors with the cognitive skills of orientation in time and space.

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VI. CONCLUSIONS: ENARRATIVITY IN THE NEXUS OF LIFE

The ability of relating objects and occurrences by means of categorizations and operations with the effect of some understanding of the world has its roots in the basic structure of life as such. As it is shown in humans, this ability is considered a phylogenetically evolved and ontogenetically developed cognitive skill, namely enarrativity. The connection between this ability and life has two different dimensions. The first is a structural conceptualization, the second an evolutionary continuity.

Let us briefly summarize the first dimension concerning the structural conceptualization. Life phenomenally shows up for the observer as a network of organismic processes, involving autonomous sustenance, development, and decay. All living beings are hence embedded in this systemic network. Consequently, living beings qua living are systems (according to Maturana) or structures (*entelécheia*, according to Aristotle) that show an autonomous organization, that is to say, a common basic capacity of self-preservation with the effect of keeping that same structure or organization. Autonomy and self-preservation are thus the two fundamental characteristics of the living system. In this vein, one might say, that living beings structurally enact self-preservation.

And mobile species keep showing this primeval organismal structure in their basic survival behaviors. Survival behaviors are indeed more complex mechanisms of self-preservation that goes beyond the bodily boundaries of the individual. The original embodied structure extends, so to speak, to the overt conduct by means of motion across the environment.

With respect to the second dimension in which enarrativity is connected with life, it is precisely through behavior that the evolutionary continuity has been made. Basic spatial orienting skills of mobile species are intrinsic to several survival behaviors like foraging or the identification of life-ensuring surroundings. The ability of orientation, thus, reaches from genetically fixed survival behaviors to understandings and actions that are detached from immediate physical needs.

We have seen where enarrativity comes from. Since enarrativity denotes the cognitive skill of constructing, that is, of arranging the phenomenal field by means of thinking and language so that we are able to understand that field of objects and occurrences, and if understanding implies assimilatory as well as accommodatory processes of cognitive orientation, then we have been talking about the structural origins of enarrativity. The orientation thesis puts forward that orientation in mobile species is a cognitive capacity that has its origins in survival behaviors. Furthermore, if survival behaviors correspond in the organismic macro-level, to some extent, to the very fundamental structure of life that we have identified as self-preservation in the organismal micro-level, then we may conceptually connect enarrativity with self-preservation. Further research would be necessary in order to make this connection in an evolutionary perspective referring to the orientation thesis, so that we can consider, at least in a preliminary manner, whether enarrativity is not only structurally, but also evolutionarily based on the basic organization of life.

This preliminary answer of the structural basis of enarrativity opens, at the same time, an initial perspective of its advantages. Knowledge acquisition is the most prominent benefit of this kind of cognitive orientation, which has considerable repercussions in the performative *accessibility* (in Noë's [40] sense of "skillful access") to the phenomenal field, as well as in the manipulative possibilities of the lived world in general.

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