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Life and Organism in Leibnizian *philosophia naturalis*

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Abstract. *This article delves into the mature philosophy of Leibniz, exploring his concepts of life and organism. It aims to establish links between the scientific discoveries of the 17th century and Leibnizian metaphysical assumptions. The paper also highlights how reflections on the Cudworthian system helped the Leipzig philosopher develop his «metaphysics of the organics». The article begins with a brief overview of the* querelle sur les natures plastiques *to deepen some Leibnizian positions on these topics. It emphasizes Leibniz's focus on the concept of organism and its fundamental relation and difference with the concept of life. The article also addresses the notion of «nested individuality» and plural individuality in the philosopher's writings, attempting to determine if such concepts exist. The solution to the coexistence of plural organisms within an organism provided here is mereological. Lastly, the article gathers current research results to demonstrate how the «organism» in the Leibnizian system of maturity is like a fold, leading readers toward different aspects of his metaphysics.*

Keywords. Life, Organism, Leibniz, Microscopy, Individuality.

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Starting from the mid-seventeenth century, the pioneers of modern microscopy began to share their observations and discoveries made in their laboratories throughout Europe. This led to a new revolution in perspective, which focused on the microcosmic world of living organisms and extremely small entities, rather than the macrocosmic view of individuals. We can call this shift a microcosmic revolution[1]. As Becchi points out, the characteristics of the new world that emerged thanks to the use of the microscope gave rise to a «new aesthetic» (2017, 2): the colors, shapes, and peculiarities of the world seen from this new perspective appeared as extremely complex and varied and finding a new way to be able to account for all this seemed necessary. During the time, many intellectuals found that the mechanistic tradition dating back to Descartes did not align with the new discoveries made by the *Micrographi*. They believed this model was insufficient in explaining the complexity of the living world. As a result, different theories were developed to address the limitations of Cartesian mechanism and create a more cohesive explanation for the new phenomena emerging from the newborn life sciences.

1. Introduction

1.1. Organism and life between the XVII and XVIII centuries

The term «life» and the closely related term «organism» thus become central to the speculations of many philosophers, *lato sensu* scientists, and doctors. It will be interesting and fruitful in this regard to observe how the term organism, before the middle of the seventeenth century, can be found only in two texts with a different meaning from the one to which we are accustomed. In the manuscript of Marciano Greco (X-XI century AD), it indicates distillation operations in the context of alchemical processes while in a twelfth-century text by Gerhoh da Reichesberg it appears to indicate a disharmonious and polyphonic concert of human voices within the ecclesiastical context. Until the seventeenth century, there are no further references to this term[2]. Starting from the microcosmic revolution mentioned above, on the contrary, we note an increasingly massive use of the term whose meaning is increasingly circumscribed: organism, in the

[1] We propose using the term «microcosmic revolution» to denote the profound impact of the Scientific Revolution's discoveries on the infinitesimal. Furthermore, we emphasize the pivotal role that laboratories played in the seventeenth century, both in theoretical and practical-experimental domains. We welcome here the idea of a laboratory as a microcosm that resumes, in miniature and artificially, the characteristics of the whole macrocosm. The insight presented stems from my analysis of the initial chapter of Wilson 1997.

[2] For the occurrence of the noun «organism», and further notations, see Cheung 2006.

singular, is used to indicate a specific organization of matter, a specific order that was not reducible in mathematical-mechanical terms and needed another explanatory level, in many cases identified with the vital one. The physician and physiologist of Halle, Georg Ernst Stahl, is the first to use the term, with this meaning, in his doctoral thesis *De Intestinis, eorumque morbis ac Symptomatis, eognoscendis ac curandis* (1684) in which he distinguishes, on the one hand, the animate bodies endowed with an active and regulating force, which will be called «tonic motion», capable of organizing organic bodies by acting on matter, according to a specific plan and regulating the homeostasis, we would say, of liquids in the vessels; and on the other hand, aggregates characterized by a greater or lesser order, but without an internal tonic force. Based on this opposition, Stahl radically distinguishes the organism from the mechanism, considering them two heterogeneous elements belonging to two opposing realities: life, on the one hand, and inert matter on the other[3]. At the turn of the two centuries, the references to the term increased and they are found in authors such as Nehemiah Grew, author of *Cosmologia Sacra* (1701) in which the concept characterizes a specific bodily order necessary to mediate between a vital principle and the regularity of the body in which it is expressed, and John Evelyn, author of *Sylva* (1706) in which he uses the term *organisms* to indicate a form of order in the plant world. It is noteworthy that during the latter part of the 17th century and particularly around 1700, there was a substantial increase in the fascination for natural life. This led to the need for a new term to resolve the limitations that arose from a strict implementation of the Cartesian geometric approach. The question concerning life, although it does not present itself as a modern problem *tout court* to the extent that it can be identified as central already in the reflections of the Greeks on the *φύσις*, is declined originally during the modern age; broadly speaking, we could say that there are two main paradigms to be taken into account: the mechanistic view, championed by Descartes, Gassendi, and Hobbes, and the vitalist view, represented by Van Helmont, Glisson, and Stahl. However, some philosophers stand out for their unique perspectives and are worth examining. In this paper, we will specifically focus on one of them: G. W. Leibniz. Studying his ideas is valuable not only because of his influence on contemporary and future thought but also because he sought to bridge the gap between ancient and modern philosophy. He believed that the Cartesian mechanism was insufficient and needed to be grounded in higher principles.

Let's turn our attention to a critical period in modern history when different tensions and forces converged. This period includes the late 17th and early 18th centuries, during which a significant controversy emerged between Pierre Bayle and Jean Le Clerc regarding plastic natures. This debate can be seen as the final major argument about the artificial interpretation of nature and its purpose (Di Bella 2015). The dispute arose because of Le Clerc's attempt to revive the Cudworthian position in his *Bibliothéque choisie* (1701). He aimed to discredit Bayle's position, which was seen as a form of skeptical occasionalism that was perilously close to atheism and to support the idea of secondary causes existence. The dispute is notable because it involves Leibniz himself, who was hesitant to participate but ultimately gave in to Lady Masham and Jean Le Clerc's persistent urging and ended his silence on the matter with *Considérations sur les Principes de la Vie et sur les Natures plastiques chez l'auteur du système de l'harmonie préétablie* (1702). This overall account of the diatribe will lead us to analyze that Leibnizian work and then to move to his *philosophia naturalis*.

[3] To deepen Stahl's position about the organic and to understand what are the implications that his theory has on his physiology and the influences on the medical school of Montpellier, see Cheung 2008.

2. Leibniz: mechanism at the service of life

2.1. Preamble

Questions about life and organisms represent a particularly extensive field of study in Leibniz's career and, in recent decades, the scholarly interest in the latter has increased significantly (see e.g., Duchesneau 1998). Life, strictly connected to the concept of organism, is a core issue that allows deepening the peculiar perspective about what, in the introductory chapter, was called Microcosmic Revolution. Thanks to the development of new technical tools from the mid-seventeenth century, many discoveries were made in this field. Leibniz's theoretical elaboration provided a unique perspective on the vital phenomena that had previously seemed almost impossible to explain mechanistically. This article delves into Leibniz's reaction to the revival of plastic natures at the end of the seventeenth century, exploring his mature philosophy and the influences exerted by the new technical tools on philosophical systematizations. By examining this historical context, we can gain a better understanding of how the problem of life and organism has evolved over time.

2.2. Leibniz's involvement in the controversy over plastic natures

As we previously discussed, Leibniz became involved in a heated debate during the early eighteenth century regarding plastic natures. Jean Le Clerc brought attention to the Cudworthian Platonic system, which was being challenged by Bayle's skeptical occasionalism. Le Clerc defended the Cudworthian system for apologetic purposes, while Bayle discredited the notion of plastic nature and Cudworth himself. Damaris Masham, Cudworth's daughter, tried to defend her father's ideas and asked Leibniz to share his perspective on the matter. Le Clerc did the same because he saw strong similarities between the Leibnizian system and that of the Platonic. Leibniz did not want to be associated with philosophers he respected but whose conceptual frameworks he did not share. As a result, he published his own views on the topic in the *Considérations sur les Principes de la Vie et sur les Natures plastiques* (1702).

In this essay, the German philosopher shows the common features between his system and Cudworth's: they both foresee the existence of immaterial substances endowed with an internal activity, strongly believing that the *novatores* abandoned too quickly the formal and incorporeal principles; they both try to combine a mechanistic description of reality with a Christian theological framework and consider that the Hylozoist perspective is fallacious as a harbinger of atheism and that the occasionalist view[4] does not give adequate justice to the causality of – and in – nature. As Di Bella points out, these similarities «ont une signification et une portée différentes, selon les diverses stratégies [...] et selon le déplacement conceptuel qui se produit en passant de l'univers néoplatonicien de Cudworth [...] à l'univers leibnizien» (Di Bella 2015, 224). In order to comprehend the fundamental differences between the two philosophers, it's crucial to take a holistic approach. This requires us to examine Leibniz's new system, which he had been refining since 1695 and which forms the theoretical basis for his departure from Platonic philosophy. By expanding our perspective in this way, we can better understand the profound disparities between their viewpoints.

[4] Cudworth's criticism is directed towards Puritanism, which, despite its differences, shares similarities with occasionalism. This happens because both views acknowledge the existence of an all-powerful God who intervenes in every aspect of reality, no matter how small.

2.3. "Non mi bisogna e non mi basta": the material plastic natures

Cudworth aimed to address the unresolved issues in the mechanistic view by exploring the organization of inanimate matter and the formation of living beings. To achieve this, sharing a vitalist perspective, he incorporated the concept of plastic nature into his system. This principle is immaterial, formal, and intangible, and it can manifest in various forms within matter. These plastic natures are the sole catalysts that can organize matter in accordance with God's plan, albeit unconsciously. In 1689, Leibniz read *The True Intellectual System* and revisited it during the dispute in the early eighteenth century. He valued it highly as it emphasized the importance of the divine in organizing natural processes and prioritized the spiritual over the corporeal. Leibniz himself, in fact, in the most refined version of his system, maintains the existence of infinite spiritual centers or «les Atomes de substance» (GP IV, 482) immersed in matter as the ontological foundation of the latter. These substantial forms, however, possess an activity that distinguishes them from plastic natures: they are endowed with perception and *appetitio* which enable them to reflect the entire universal reality. However, they do so through their own organic body. This happens on the ground of that «communication» which is the true «union de l'âme et du corps» (GP IV, 484-485) and therefore of any entelechy with its own body, which implies perfect parallelism and correspondence between the succession and modification of bodily states and those of the perceptual states proper to the soul. This hypothesis is what in Leibnizian mature philosophy is called the «Systeme de l'Harmonie preétablie» (GP VI, 540); this locution allows us to open the way to a further aspect of the correspondence between soul and body: it is guaranteed by God *ab origine temporis* since only a general and omnipotent cause would have been able to do this. In the *Considérations* Leibniz starts precisely from his theory of pre-established harmony as opposed to the Cudworthian position of a direct intervention of plastic natures on matter and, for this reason, he refers to the key principle of his dynamics according to which «[c]orpus non moveri nisi impulsum a corpore contiguo et moto» (GP VI, 541). According to the principle of sufficient reason, repeatedly recalled in his texts, if a body can only be moved by another body that is contiguous and moving, then no plastic nature can intervene on the bodies and matter. This implies that the physical world is causally closed and that any events occurring within it must be explained mechanically. Undoubtedly, thanks to the harmony established by the Divine Architect, there is a perfect correspondence between what happens at the level of bodies and what is perceived at the level of entelechies and, therefore, between the realm of efficient causes and that of final causes to the extent that the original Author of all things has omnipotence and extreme wisdom. In the *Considérations* Leibniz goes on to argue that, from his point of view, the entelechial principles are immortal and everywhere; indeed, he emphasizes, according to the theory of preformation which he embraces and to which we shall return, that the animal in its entirety, that is, the soul together with its organic body, is neither born nor perish because animals undergo only quantitative transformations. At this point, however, we come to the heart of the essay, when Leibniz asserts as follows:

> Je suis donc de l'avis de Monsieur Cudworth [...] que les loix du Mechanisme toutes seules ne sauroient former un animal, là où il n'y a rien encor d'organisé; [...] [e]t je fortifie ce sentiment de M. Cudworth en donnant à considerer que la matiere arrangée par une sagesse divine doit estre essentiellement organisée partout, et qu'ainsi il y a machine dans les parties de la machine naturelle à l'infini, et tant d'enveloppes et corps organiques enveloppés les uns dans les autres, qu'on ne sauroit jamais produire un corps organique tout à fait nouveau, et sans aucune preformation, et qu'on ne sauroit detruire entierement non plus un animal déja subsistant. Ainsi, je n'ay pas besoin de recourir avec M. Cudworth à certaines Natures Plastiques immaterielles […]. J'en puis dire «Non mi bisogna e non mi basta» […]. (GP VI, 544)

As Di Bella observes, it should be noted that Leibniz operates here a significant «transcription conceptuelle» (Di Bella 2015, 228) because it appears that at this theoretical level, he may have shared the same perspective as Cudworth while he translated Platonic concepts into his systemic reflection. According to the German philosopher, plastic natures «non mi bisogna[no]» because their functions are carried out, in his system, by organic bodies that bear a trace of the divine in their *emboîtement* that continues *ad infinitum*. This passage also contains an allusion to the concept of «divine machines». They are considered divine because they are organized by God and go down *ad infinitum*. As such, they are machines because they are under mechanical laws[5]. Plastic nature is therefore, for Leibniz, material, in the sense that it is nothing but the organism which is only a more exquisite and divine form of mechanism[6], both concepts acting at the level of the series of efficient causes, i.e., as bodies rather than souls. On the other hand, for Leibniz these immaterial principles «non mi basta[no]» because they are simple intermediate instruments between God and matter, an idea at risk of dangerous reductions, as it is shown by Bayle's critique of the Platonism rehabilitated by Le Clerc. Here we can recognize the conceptual shift mentioned above: Cudworth's plastic nature is, in his system, equivalent to the organism which is a mechanism and therefore «il déplace la fonction plastique [...] et la terminologie même de nature plastique, du niveau métaphysique et incorporel au niveau physique et matériel» (Di Bella 2015, 231) advocating a physicalization of the plastic principle. In this way, we fall from a metaphysical into a physical level referred, for a complete understanding, to the *oeconomia animalis*, to the *Système nouveau* and his interests in physiology, biology, and chemistry. Only by opening the wide-ranging perspective, it will be possible to understand in depth this conceptual transcription, whose implementation lies in the concept of life outlined by Leibniz.

2.4. The hydraulic-pneumatic-pyric machine: the animal economy in Leibniz

By «animal economy» Leibniz means the discipline that studies the relationships and coordination of organs and functions within an organic body. It disregards any reference to the soul so that everyone knows that the animal body is a «machinam Hydraulico-Pneumatico-pyriam» unless «chimaericis principiis animum occupatum habeat, veluti animabus divisibilibus, naturis plasticis, speciebus intentionalibus […]» (Stahl 1720, Ad. XIII). If someone applies the mentioned principles in a physiological-biological investigation, they are undoubtedly mistaken, Leibniz says. The controversy with Stahl, as Smith (2011, 64) notes, is the only place where Leibniz rigorously discerns the essentially empirical level of *oeconomia animalis* from his metaphysical reflection on animals, which he had refined since 1695. Leibniz's use of the term «hydraulic-pneumatic-pyric machine» demonstrates his connection to both the iatrochemical and iatromechanical traditions. He sought to preserve the mechanistic model while acknowledging its limitations in describing living organisms. One of the first writings showing his analysis of animal economics is the *Corpus Hominis* (1680-1686) in which he asserts that every animal body is a particular kind of perpetual motion machine, or, in Smith's expression, a «machine of quasi-perpetual motion» (Smith 2011, 70). In fact, unlike artificial machines that receive the *primus motus* from the outside and, specifically, from man, it is self-propelled, it must

[5] We will analyze this issue later, see Smith 2011.

[6] «Differentiam etiam inter Mechanismum et Organismum crebro inculcat idem […] etsi, ut verum fatear, omnis organismus revera fit mechanismus, sed exquisitor, atque, ut sic dicam, divinior; dicique possit […] corpora naturae organica revera machinas divinas esse». (Stahl 1720, Ob. II).

seek food by itself to consume it and obtain energy to spend on self-preservation and reproduction. Introducing a sort of «vital chemistry» (Duchesneau 2014, 110), Leibniz compares the first engine of the machine to a flame which, as long as nourishment and ventilation are not lacking, will continue in its boiling motion that spreads vegetative force throughout the body through animal spirits[7]. Leibniz cites cardiac motion and breathing to support his analogy, relying on a mechanistic theory that contradicts Cudworth's perspective. The analogy with the flame also returns in the controversy with Stahl, where Leibniz points out that what the Halle doctor calls «life» is defined by him as «vegetation» because the functions of the animal body can all be described according to mechanistic canons, moving from the structure of the organic body and the functional relationship between its organs[8]. This account is related to the animal economy. It eliminates the need to refer to the soul to explain certain biological phenomena, such as cardiac motion or respiration. According to this account, the organic body is similar to a flame that consumes oxygen from its surroundings to grow. It reaches out in all directions to seek oxygen, and if it doesn't find it, it eventually dies. As we've previously observed, the animal body also seeks out resources in its environment for survival. When it cannot locate these resources, its functionality deteriorates, eventually leading to the collapse of the entire body's architecture – for this reason, it is a machine of *quasi-perpetual* motion. It is thus shown that the organic body is in perpetual osmosis with the external environment, it is like a river that constantly flows, whose cohesion is guaranteed by the structured organization of its parts[9]. The biological, chemical, and physiological characteristics of the organic body can be understood on the ground of its structure and, in this case, one should not speak of «life», as Stahl does, but only of «vegetation», as Leibniz maintains thanks to the metaphysical system he elaborated starting from 1695. When it is necessary to give a reason for the validity of the animal economy, the metaphysics of the organics come into play, representing one of the main innovations of the Leibnizian *philosophia naturalis* of maturity.

2.5. The metaphysics of the organics: machines of nature and «nested individuality»[10]

As can be seen, Leibniz identifies a physiological-mechanical model of *lato sensu* vital processes, at least since he wrote the *Corpus Hominis* (1680-1686). About this issue, we need to understand how this model harmonizes with the metaphysics of the organics that he draws, or rather, quoting an effective expression of Nunziante, how Leibniz «[dia] vita ad una *meccanica dei processi vitali* che è al tempo stesso anche espressione della *finalità armonica* che regola l'organizzazione delle parti, e nella quale dunque si esprime, *riflet-*

[7] See LH III, 2.

[8] «Ego haec ad vegetandi vim referebam, qua corpus vivum sese perficit, nutrit […] quod ex ipsa structura machinae consequi puto; etsi anima ubique conspirante. Et videmus aliquid vegetationi analogum in corpore maxime fluxili, sed minime vivo, nempe flamma, quae sese nutrit propagatque, et alimento deficere incipiente, miri motibus discurrit, id agens ut se tueatur. […] Sed de vocabulo litigare nolim. In arbitrio autoris est vitam appellare, quod alii vegetationem» (Stahl 1720, Ob. IX).

[9] «Si corpus perceptione et appetitu careret, credo non magis vivum appellari mereretur, quam flamma ad se nutriendam laborans.» (Stahl 1720, Ad. VIII). In the following point Leibniz continues: «Accedit transpiratio perpetua, aliaque adsunt indicia multa, ex quibus patet corpora animalium non tantum nutrimento per intervalla assumto indigere, sed et fluminis instar in continuo fluxu esse» (Stahl 1720, Ad. IX). The argument of the river emerges also in the *Monadologie*: «[T]ous les corps sont dans un flux perpetuel comme des rivières; et des parties y entrent et en sortent continuellement» (Monad. §71).

[10] See Nachtomy 2011 and Smith 2011.

tendosi, il principio armonico di perfezione di cui si struttura l'intera vita del *cosmo*» (Nunziante 2002, 130). For the German philosopher, the *novatores* «ont porté la reforme trop loin […] entre autres en confondant les choses naturelles avec les artificielles» (GP IV, 481) because, taking man-made machines as a model of natural reality, some mechanists have ended up arguing that the only difference between them is in the degree whereas, actually, the difference is «dans le genre même» (GP IV, 482). Leibniz writes, at the heart of the *Système Nouveau*, that

> [u]ne machine naturelle demeure encor machine dans ses moindres parties, et qui plus est, elle demeure tousjours cette même machine qu'elle a esté, n'estant que transformée par des differens plis qu'elle reçoit [...]. (GP IV, 482)

Here the author brings together multiple instances of his metaphysics of the organics. The machine of nature is any organic body, organized according to a certain purpose and always provided, on an ontological level, with a substantial form or entelechy which is what makes it one, even if, on a conceptual level, it is possible to think of them separately. Therefore, there are no bodily substances devoid of the organic body or the soul: these two requirements are always ontologically present even if, on a logical level, it is possible to separate them. The *machina naturae* is very different from the artificial machine built by man: the first is infinitely complex and consists of infinite organic machines that unfold *ad infinitum*, with no lower limit to this development; on the other hand, the second, being the product of a finite being such as man, in the analytical proceeding, will turn out to be limited. If that is the case, we may encounter components that are no longer machine-like and structured according to human design. Alternatively, we may come across natural elements that serve as essential parts of an artificial machine. According to Nachtomy's interpretation, there are two ways to understand this natural machine's properties, which remain consistent even in its smallest aspects. One interpretation is structural, while the other is functional (Nachtomy 2011, 72). As far as the first one is concerned, as we can also read in paragraphs 67 to 70 of *Monadologie*, what extends *ad infinitum* is the structure of the natural machine, which implies machines within machines in what is defined by Nachtomy as «the nested structure of natural machines» (Nachtomy 2011, 73). Only the machines of nature are characterized by this structure that consists of different levels of *emboîtement* which, however, gives rise to the same *mereological* relationship, whether we focus on the macroscopic or look at the microscopic level. On the other hand, the functional reading suggests that machines within machines validate the concept that each machine has a specific function and purpose, both at the machinic level and in the organic entity to which it belongs as a part (Nachtomy 2011, 78). The first reading here appears to be the most beneficial as it connects the *machina naturae* with what Leibniz refers to as *organismus* in the singular form. To back up my stance, let's examine the excerpt below. It's from a letter dated May 1704 that the philosopher Leibniz sent to Damaris Masham, where he declares his belief that

> [...] l'Organisme, c'est à dire l'ordre et l'artifice, est quelque chose d'essentiel à la matière produite et arrangée par la sagesse souveraine [,] la production devant doit toujours garder les traces de son auteur. (A II, 221)

Even in its smallest parts, the machine of nature maintains continuity through the principle of the organism. This principle is order and artifice through God's organization of matter, allowing it to escape chaos. It's important to note that this doesn't require any immaterial principle. God established a series of efficient causes from the beginning of time, ensuring that matter is organized according to mechanical principles and becomes

an organic body. Therefore, an organism is a mechanism that acts as a singular principle of body organization and not something opposing it. So, we can understand that Leibniz adheres fully to a mechanistic view. For this reason, when Leibniz refers to the organics in the *Considérations* first, and then in the controversy with Stahl, he thinks of something that is mechanically ordered, even though the organism is a mechanism more exquisite and more divine, as a product of God and, therefore, spread throughout reality, at several levels, *ad infinitum*. Another fundamental principle of the Leibnizian metaphysics of the organics is outlined here: the latency of the organics in the inorganics. According to the Leipzig philosopher, it is possible to find in every portion of matter, even if not organized, even in its smallest parts, the so-called machines of nature, organic bodies encapsulated within each other, at several levels. There are various instances where this principle is elucidated. However, for now, let us just remember §66 of *Monadologie*. In this paragraph, Leibniz underlines the importance of this principle saying that «l'on voit qu'il y a un Monde de creatures, de vivans, d'Animaux, d'Entelechies, d'Ames dans la moindre portion de la matière» (Monad. §66). What in Cudworth's conception was «plastic» here becomes «organic», that is, what is capable of growth, motion, and of all those activities that we could call «vegetative» or vital in a broader sense. All these functionalities can be deduced from the infinite complexity of the organic body, regardless of formal principles.

Once we establish this, an important question arises about what remains of individuals. We need to consider the unity that goes beyond the infinite complexity of natural machines. Here the model of «nested individuality» comes into play, as we can see in various Leibnizian writings, including the *Système Nouveau*. According to this model, an individual substance is comprised of a dominant entity that animates and organizes its organic body. In his argument with Stahl, Leibniz refers to this as a unity between an actuating monad and its body[11]. The body itself is made up of countless other individual substances, which in turn are made up of infinite other organic substances, and so on indefinitely. Leibniz is thinking of plants and animals as models because of their hierarchical structure that can be seen all the way down to the microscopic level. As Smith notes, a «plural notion of individuality, which recognizes infinitely many levels of it within any corporeal substance» emerges and in this model «individuality and unity are defined through activity» (Smith 2011, 141-142), that is, the dominant entelechial form that, according to a main purpose, gives meaning to the whole, i.e. to the integration and organization of all organic bodies encapsulated one within one other. It is blatant that we are progressing from the basic stage of the mechanical-organic body to the more intricate level of the individual body substance.

2.6. Life, or the role of the soul in its peculiar relationship with the body

«At vero, etsi in materia omnia explicentur Mechanice, non tamen omnia in ea explicantibur materialiter» (Stahl 1720, 1), Leibniz writes in the preamble to the objections to Stahl. It appears that this observation aligns with the philosophy of Cudworth: we need to acknowledge that there are limitations to the mechanistic approach, to the extent that not everything can be accounted for within a geometric-material framework. *Pro* Cudworth Leibniz argues that the very principles of mechanism cannot arise from matter and therefore they must depend on a higher level of reasons, specifically on teleological reasons; *contra* Cudworth he never dismisses the causal closure of the physical world, which leads him to introduce entelechial forms that do not

[11] «Assentior etiam nullum esse corpus Naturae organicum, omni Entelechia primitiva seu monade actuatrice […] perfecte cassum; nec ullam esse animam naturaliter ab omni corpore organico separatam» (Stahl 1720, Ad. XXI 16).

intervene on their bodies. The primary issue is the clarity of these nearly concealed principles. In Leibniz's perspective, this is the most significant mistake that should be addressed, which he does on various occasions, including during the dispute with Stahl, as accurately noted by Nunziante (2011, 127). If the laws of mechanism refer to a higher order, the actions – and not movements[12] – of bodies require a principle of a formal nature that is bound by metaphysical rules, just as the organic body is bound to the rules of *mathesis*. Once again, we see the significance of pre-established harmony. The bodily states follow the path of efficient causes, while the psychic-formal ones follow the path of final causes. This concept of parallelism relates to specific and general causes. The specific efficient causes refer to organic bodies, while the general efficient cause is God. The specific final causes are found in natural machines and substances that exist to preserve themselves and their species. These specific final causes are part of a larger teleological project established and desired by God[13]. Through this perfect correspondence, we are able to analyze the entire course of events from both the final and efficient causation perspectives simultaneously. At this point, one may wonder about the role of the soul - the formal principle capable of action that follows final, not efficient reasons. The simple substance has the function of unifying the countless natural machines that constitute its organic body according to a holistic purpose. This makes the body alive and not just a mere aggregate. This can only be achieved through its representative and expressive actions, in which it portrays all the changes occurring in the body, regardless of any direct physical connection. These actions include perceptions – even infra-conscious – and desires, thus ensuring the psychological and formal representation of bodily changes, as well as efforts to move from one appetitive state to another. These activities are all necessary for what Leibniz refers to as «life»[14]. Nunziante correctly argues about the co-essentiality and co-implication of these two levels by observing that the discrepancy of the «differenti livelli ontologici entro cui si svolgono le funzionalità organiche della macchina naturale non introduce una distinzione conoscitiva tra il piano corporeo della "fisiologia meccanica" e quello "percettivo" presieduto dall'anima, dal momento che ciascun livello implica reciprocamente – e *necessariamente* – l'attività dell'altro affinché l'organismo sia concretamente vivente [...]» (Nunziante 2002, 147). Therefore, the soul is the representative element of the body without which the latter could not be considered living. This emerges in many of Leibniz's works where he insists precisely on the fact that without the soul or entelechial form, one cannot speak of life but only of vegetation. In practical terms, it is important to recognize that organic bodies and entelechial forms are always intertwined in the reality we inhabit. This ideal separation is not possible in our world. It is possible for a part of an organic body to be expelled from it without having a dominant entelechy that actualizes the holistic perspective. In such cases, this part becomes a mere inorganic *aggregatum*. However, due to the omniextensive latency of organics, it can still hide an infinity of organic bodies. Living organisms, which are bodily substances consisting of both soul and body, derive their vitality from the mutual co-implication of different organic components. The soul acts as the guarantor of this process, subsuming the movements proper to the latter according to a teleological orientation. This superior expressive subsumption is what allows us to speak of «life» about bodily substances. This also enables unity through *a* multi-level coordination of mechanical movements that align with the soul's perceptions. Therefore, the actions of

[12] Distinguishing between action and movement is important, as Leibniz defines actions as solely the *perceptiones* and *appetitiones* of the soul, while movements refer to the various modifications of the organic body of the entelechy being examined.
[13] See Stahl 1720, 2, but also see Monad. §79.
[14] See GP IV, 477-487; see GP VI, 598-606; see Stahl 1720, Ad. XXI.

the soul, the appetitions, and perceptions are vital, so it can be said that «la vita può allora essere descritta nei termini di una attività che si esprime meccanicamente, ovvero di una forma che trova espressione, e quindi realizzazione, a livello meccanico» (Nunziante 2011, 162). This means that life, despite being formal, is actually realized at the mechanical level. However, this can only happen if there is a perfect correspondence between bodily and psychic levels. Ultimately, this occurs thanks to God who established a universal harmony from the beginning of the time. The soul, according to Leibniz, is therefore not a «chimerical cause», it is not an ilarchic principle or a plastic nature but rather a formal-representative principle that expresses the actions of the organic body that, as an organic entity, is organized. Finally, to better understand the difference between organism and life and hence the exceptionality of the latter in the Leibnizian system, it is helpful to refer to Leibniz's argument with Stahl about the explanted heart: even if the heart continues to beat after it has been removed, it doesn't mean that it is animated (Stahl 1720, Ad. XXI, 17). The pulsation of the object is a result of the animal spirits within it, which mechanically reflect the actions of the entelechies present throughout. The organism is a mechanical system, albeit a more sophisticated and divine one, while life is a unique entity that cannot be explained solely through mechanical or geometric reasoning. If Nunziante appropriately maintained that «l'organismo si configur[a] come una sorta di *punto di contrazione* dell'intero sistema e rappresent[a], per così dire, il luogo in cui l'intera natura, considerata nella *integralità* delle sue determinazioni, trova la sua *espressione* più alta» (Nunziante 2002, 186), as far as the purpose of this paper is concerned, this definition can be reformulated by saying that the organism presents itself as the *fold* of the entire Leibnizian system, on whose *ridge* we find, in convergence, the themes of mechanism and life but also many new elements coming from the different life sciences to which Leibniz appealed. With this metaphor, we want to underline how the concept of organism presents itself as a sort of crossroads from which we can move both towards the Leibnizian animal economy and its metaphysics of the organics. Now it's time to turn our attention to the intertwining of philosophy, on the one hand, and science and technology, on the other, focusing in particular on a theme that, until now, has been left quiet, namely that of the preformation of animals, so that the picture drawn can be completed.

2.7. The microscope, the nested individuality, and the preformation theory in the Leibnizian system

Leibniz writes in an essay dated 1697-1698, dedicated to exalting the progress of his contemporary era, that

> [l]es microscopes nous font voir dans le moindre atome un monde nouveau de creatures innumerables [...]. La Chymie, armée de tous les elemens, travaille avec un succès surprenant à tourner les corps naturels en mille formes, que la nature ne leur auroit jamais données ou bien tard. (GP VII, 174-175)

In the Leibnizian texts, there are many references, implicit and explicit, to the works and observations of the main microscopists of the time such as Leeuwenhoek, Swammerdam, Malpighi, Hartsoeker, and Kircher. This shows Leibniz's interest in this field and to better understand his purpose it will be useful to look at his biographical events. The influence that Kircher exerted on the young Leibniz was significant because, as Wilson (1995, 76) reports, the first owned a microscope as early as 1634 and, from here on, began to publish many illustrations of what he could see thanks to this amazing tool. It is not difficult to speculate that Leibniz borrowed a passion similar to Kircher's one for the extremely small. The long stay in Paris (1672-1676) was then very fruitful as Leibniz

increased his knowledge about the microscope and the discoveries that had been drawn thanks to it. In 1675 he read the *Recherche* of Malebranche in which the theory of preformation was lowered into a Cartesian metaphysical framework and the references to microscopists were manifold. During this time, he had the opportunity to visit London and to meet Hooke, who allowed him to attend some experiments. On his way back from England he stopped in Holland where, in addition to meeting Spinoza, he made the acquaintance of Swammerdam and visited his insect collection. Of all the meetings, however, the most exciting was the one with Van Leeuwenhoek, the first scientist to study protozoa under a microscope (Becchi 2017, 5). Thus, the recent invention of the microscope and the study of organic microstructures became a central component in investigations and reflections on the living world (Wilson 1995, 181). It seems that Leibniz goes on as a «microbiological metaphysician» (Smith 2011, 97) who uses microorganisms such as spermatozoids as a paradigmatic model of the living. From the infinity of organic bodies within organic bodies to the theory of the preformation of the animal as a whole, passing through the idea of quantitative transformation rather than the birth and death of animals, up to the «biological» peculiarities of what constitutes the set of building blocks of reality and the principle of uniformity of nature: many elements of what was previously called «metaphysics of the organics» would thus seem to be derived from a strong influence that the microscopic world was exerting on Leibniz. We are not arguing here that Leibniz would have elaborated his metaphysics starting from the observation of certain empirical discoveries; rather we think that he elaborated his various theories in constant dialogue with microscopy and its discoveries and, even more, sought in this empirical research *a posteriori* validation of what he had already deduced *a priori* – or that could have been deduced *a priori*. In this regard, it suffices to quote what he says in §76 of *Monadologie*: «[...] [e]t ces raisonnements, faits *à posteriori* et tirés des expériences, s'accordent parfaiment avec mes principes déduits *à priori* comme ci-dessus» (Monad. §76). On the ground of previous discussions, what follows will focus on the influence that microscopic discoveries had on the infinitely complex structure of individual substances and Leibniz's decision to embrace the theory of preformation, even without taking explicit part between animalculists and ovists.

The Microcosmic Revolution opened new perspectives during the seventeenth century: the paradigmatic models in the description of the living and natural reality were no longer macroorganisms like horses or men, as it was, e.g., for Aristotle, but became microorganisms like worms or larvae. If before this century the cohabitation in the same body by several microorganisms was seen in terms of parasitism, thanks to the new interests that emerged with the microscope, this con-substantiality of the *micro* and *macro* began to be read in terms of very small worms that *constituted* the larger animal (Smith 2011, 144). Leibniz translated this into his theory of «nested individuality», as Nachtomy puts it, or the theory of worlds within worlds, organic bodies within organic bodies *ad infinitum*. If we accept the idea that the German philosopher spoke about worms with a much broader meaning than the one we are used to, we will understand how bodies – and, by extension, the whole of reality – were for him made up of an infinity of worms, i.e. microorganisms. On the other hand, this was what Hooke, Leeuwenhoek, and Kircher had been showing for a long time. This idea of bodies within bodies explicitly refers to the definition of the organic body as a «hydraulic-pneumatic-pyric» machine in constant osmosis with the environment. As we have seen, Leibniz sees the body as a river constantly flowing; if we picture it as made up of worms, we can also have a better figurative image of how the interchange with the environment could take place without the loss of the unity and individuality proper to an individual substance. Moreover, as proof of the influences of the new life sciences on his reflection, this idea of the interchange between body and environment seems to have been borrowed by Leibniz from the chemical and iatrochemical conception of nutrition and fermentation

(Duchesneau 2011, 19). It can therefore be said that the Leipzig philosopher received and reported in his metaphysical system one of the most astonishing implications given by the microscope: «[...] there is nothing fundamental or bottom-level about microorganisms at all» (Smith 2011, 159). *Animalcula in animalcula ad infinitum*: this was what the microscopists were showing, and Leibniz immediately received in his metaphysics of the organics.

In this paragraph, we have yet to address an important topic in Leibnizian mature philosophy: the theory of preformation. We have chosen to save it for last, in order to present a cohesive argument that highlights the central role of Leibnizian preformation in refuting Cudworth and the supporters of «chimeric causes», to which he appealed in the *Considérations* previously considered. The Cantabrigensis suggested the concept of «plastic natures» also to explain embryogenesis, which couldn't be explained through mechanical view alone. In this theory, an immaterial principle shapes and organizes inert matter to bring living beings into existence. On the other hand, as we saw, Leibniz believed that the soul does not create the body, given the physical world's causal closure. The way the German philosopher finds to solve the problem of the emergence of the animal is the theory of preformation according to which God would have preformed *ab origine temporis* all living individuals. The growth of these would be nothing more than a quantitative increase, without qualitative modifications, of an already organized matter because, otherwise, it would be impossible to explain the emergence of the organic – organized – from the inorganic – unorganized (see GP VI, 545; see also GP VI, 601; and also Monad. § 72-74). *Pro* Cudworth, he points out that mechanical laws cannot be used to explain embryogenesis; *contra* Cudworth, he abandons any idea of the telic process at the base of the origin of the living, choosing instead preformism. On the other hand, this account was related to his theory of pre-established harmony, therefore to a particular form of correspondence between macrocosm and microcosm, closely linked also to the principle of uniformity of nature that he embraced. If, according to Harlequin's motto, «que *c'est* tousjours et par tout en toutes choses *tout comme* ici» (A II, 232), both spatially and temporally, everything will be as here and now, in the past and the future and, for this reason, given that the mereological relationship within the animals must always be preserved, one can only conclude that they have been preformed and that they do not die naturally. Leibniz, therefore, speaks of *metamorphosis* or quantitative transformation of what usually takes the name of birth or death: there are only quantitative developments or envelopments of the same animal, therefore of the entelechy united to its own organic body. The animal is contained in miniature in very small seeds[15] that will grow until the animal perishes, returning to those seeds that will shrink until they become invisible to the naked eye. As we delve into empirical sciences, we can identify two significant discoveries that greatly impacted Leibniz's development of this theory. First, Swammerdam's observation of insect metamorphosis[16], and second, the discovery of microorganisms[17]. These findings allowed the philosopher to recognize the preformed soul as a concrete bodily vehicle. As for this second respect, it was Leeuwenhoek's discovery of spermatozoids that enlightened Leibniz about the preformation of the living. As for the first issue, the metamorphosis studied by entomologists such as Swammerdam represented the exemplary paradigm of what happens when death comes. For this

[15] These seeds can also be considered a Leibnizian resumption of the Stoic seminal reasons, which, in this way, find a peculiar accommodation in its system, becoming a vehicle of the preformed animal. In this regard, see Smith 2011, 175.

[16] For an in-depth analysis of the main theories about metamorphosis and the different ways of categorizing insects between XVI and XVII centuries see Ogilvie 2014.

[17] For more information about this topic see Abou-Nemeh 2014.

reason, we must not speak of real death, but only of a transformation of the organic body: as the larva and the butterfly are the same animal, as has been shown by Swammerdam, so, also the animal body that seems to perish does nothing but turn into a much smaller animal that, however, is nothing other than the first because of the maintenance of the same mereological structure. Consequently, the preformation of living substance is a consequence both of the infinite complexity of the machine of nature and of the doctrine of pre-established harmony and the principle of uniformity that accompanies it. The harmony of the soul with its own body wants this body to be present since Creation. The divine preformation thus plays an essential role.

3. Conclusion

In this paper we tried to show how, guided by the principle of sufficient reason, Leibniz came to formulate «une théorie architectonique du vivant» (Duchesneau 1998, 370) which gives a peculiar account of those problems that, left unresolved by the post-Cartesian mechanists, had intercepted Cudworth's attention in the conviction of being able, appealing to those, to support the use of immaterial plastic principles. The charm of the Leibnizian system is linked to its ability to combine mechanism and teleology, modern science and Christian theology: the harmony established by God allows us to understand the relationships between entelechial forms and organic bodies while maintaining the causal closure of the corporeal to the psychic-formal and vice versa. For Leibniz, plastic natures «*are not necessary and not enough*» because in his system everything that pertains to vegetation in a broad sense can be explained mechanically by appealing to the organism, which is a more refined and divine form of the mechanism. The German philosopher thus succeeds in integrating the artificialist model, dominant at the time, into a vital framework whose guarantee lies in God. One can therefore understand why Duchesneau, as we saw, can speak of an architectural of the living if we consider the different levels – physical and metaphysical – that intersect in what we have called the Leibnizian «metaphysics of the organics». It also emerges even more clearly why, previously, reformulating Nunziante's definition, the organism was considered as a *fold* of the entire Leibnizian system: in this last concept all the developments of his mature reflection converge and it is from this point that the complete deployment of the architectural of the living just mentioned is possible. From the organism – or, perhaps, we could say, from the organic body – following the folds of Leibnizian reflection, we arrived at the concept of life, which turns out to be very different from that of vegetation and therefore very different from that implicitly emerged in Cudworth, where life was informed by the plastic principle in the matter so that this one, once organized, could fulfill the typical functions of the living. Leibniz believes that these functions can be explained mechanically, and that life refers to a higher metaphysical level, the only one able, moreover, to account for the unity of living substance. Thus, one can understand the eccentricity of the Leibnizian position which, acutely, pursues an intermediate path between the mechanism *stricto sensu* and the vitalism of the sixteenth-century Platonics.

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Abbreviations

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