Convergence Between Chemistry and Biology in the Leibnizian Concept of Organism

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Abstract: In his work Leibniz provides different approaches to the idea of organism. In the present paper I would like to focus on two of them. On the one hand, we find a chemical approach that studies the organism as a composite body. On the other hand, from a biological perspective, the organism is the result of a natural generation, *i.e.* the development and transformation of organic structures. The thesis that I defend in this paper is that both perspectives are convergent in the same ontological project built around a certain understanding of the chemistry that Leibniz proposes in his latest works.

Keywords: *G.W. Leibniz, chemistry and biology, organism, eduction, preformation*.

1. Introduction

Why is chemical and biological thought important to understanding Leibniz's philosophy? Did Leibniz contribute something original to both disciplines? In this paper I answer these questions in the context of Leibniz's conception of an organism. I show how Leibniz proposes an alternative definition of an organism as opposed to those suggested in his time: the mechanistic and vitalist (or animist) definition, respectively, and how he was inspired by the chemical and biological thinking of his time.

The paper is divided as follows: in the Section 2 I provide a general introduction to the question of the importance that chemistry and biology have in Leibniz's work, which is transparent in the number of texts he dedicated to these disciplines, and the main sources that left trace in the earlier period of his work, in particular, his philosophy of nature. This is of great importance, since the young Leibniz was mainly inspired by the chemistry of his time to create a 'new physics'. Leibniz understood this 'new physics' as an alternative to, as well as a reformation of, Cartesian mechanics. From this model Leibniz developed his theory about both physical entities (minerals, metals, or chem-

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ical species) and biological entities (living beings). In the Section 3 I show that Leibniz offers two perspectives to the idea of organism (constitutive and generative): an organism can be understood as a physical entity (a body composed of parts or organs) and at the same time as a biological entity (it is the organic body of a living being endowed with a soul and product of a natural generation). This tension between the two approaches to the idea of organism is present in the way Leibniz criticizes both the mechanistic and the animistic definition. I discuss this question in the Section 4. In Section 5 I focus on the Leibnizian idea of organism. To define an organism as a composite body Leibniz made use of the chemical theory of his time about compounds and the idea of eduction. In Section 6 I develop the second type of approach to understanding the organism: the generative one. An organism is from this perspective the body of a living being that is the product of a natural generation. I briefly explain Leibniz's preformationist position. In the Section 7 I discuss Leibniz's definition of chemistry in one of his last works as a way in which the two approaches manage to integrate the idea of organism, the constitutive or chemical and the generative or biological one. The interpretation of the Leibnizian conception of the organism that I propose in this paper presents some problems, as we shall see in the last section devoted to the conclusions. Despite the inherent problems, it allows us to highlight (1) the originality of the Leibnizian idea of organism as opposed to the mechanistic and vitalist conceptions of the time; (2) the methodological contribution he made to the study of organisms from the integration of various disciplines; and (3) the timeliness of the ontological framework from which this conception of the organism is defined.

2. Chemistry and Biology in Leibniz's Work

Chemistry (or chymistry, see Newman & Principe 1998), medicine, anatomy, and physiology are disciplines that are very present in Leibniz's thought. Leibniz's interest in being at the forefront of all the disciplines of early modern science is apparent in his entire work. His achievements in the fields of physics and mathematics are well known. To this day, the importance that the chymical and 'biological' thought had in Leibniz's philosophy is still debated. On this issue there is much to investigate and discuss since most of his texts on these topics have not been transcribed yet (nor, therefore, published). If we look at the data provided by the Leibniz-Edition of Berlin (see Figures 1 and 2) – the center responsible for publishing the works on these subjects – many of his texts are dedicated to medicine (more than 3000 pages). In contrast, on chymistry and biology we find only about 100 pages.

However, texts classified as medicine are full of reflections on chymistry and biology (and vice versa)[1]. The reason for this is not only that these disciplines were not yet established as such, but also because for Leibniz they are intimately related. As we shall see, a good example of this can be found in the context of his conception of organism.

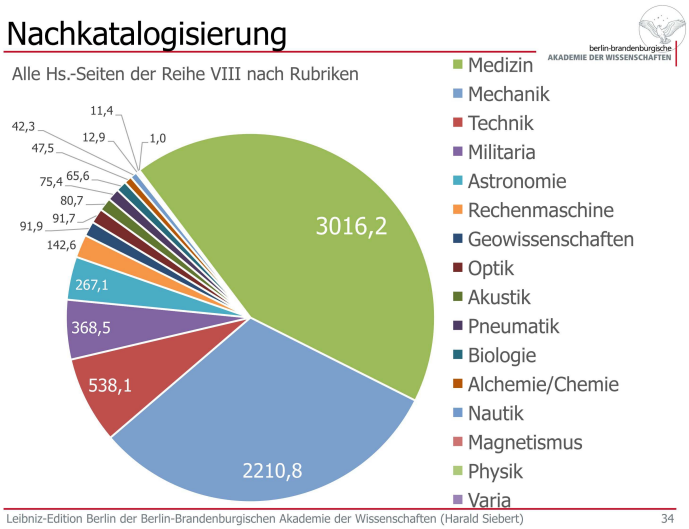

Figure 1. Number of pages per subject. (Source: Leibniz-Edition Berlin [http://leibniz-berlin.bbaw.de/forschung-aktuell/nachkatalogisierung/view], reproduced with permission of Berlin-Brandenburgische Akademie der Wissenschaften)

The number of texts on issues related to chymistry and biology is a first indicator of the importance that these disciplines had for the German thinker. But what interested Leibniz in the chymical and biological thought of his time? First of all, he saw in them a source from which to enrich the prevailing mechanistic thought. This idea grew in Leibniz as he became aware of the deficiencies of Cartesian mechanics. Similar to Descartes and other great scientists of the time, such as C. Huygens, Leibniz wanted to develop a general science whose principles were able to account for all natural phenomena. However, in contrast to the French thinker, Leibniz claimed that it was not necessary to break with the previous thought, but to integrate it in the current one. These ideas can be found in his youth project in which he attempted to develop a 'new physics' (see: *Hypothesis physica nova* and *Theoria motus abstracti* from 1671, A VI, 2, pp. 219-257 and A VI, 2, pp. 258-275). One of the main problems facing this 'new physics' was to explain the unity and co-

hesion of bodies. In Leibniz's opinion this was the great problem of Cartesian mechanics. Along with it, Leibniz also mentions the problem of the origin of the qualities of bodies (*e.g.* A II, 1, p. 92 and A VI, 1, p. 491). To solve both problems, Leibniz thought it was necessary to recover the Aristotelian notions of form, purpose, and change, and to think of them as qualities intrinsic to bodies (*e.g.* A II,1, pp. 25-26,31, GP IV, pp. 447-448). It was precisely the chymical and biological thinking of authors such as J.B. van Helmont, R. Boyle, W. Harvey, J. Swammerdam, Sylvius, T. Willis, and D. Sennert that would eventually indicate Leibniz to *naturalize* the ideas of form, purpose, and change. In contrast to their abstract and metaphysical definition, naturalizing these ideas meant to define them in a concrete and causal way in accordance with an empirical and naturalistic view more in keeping with the interest of modern science in the study of the complexity of bodies.

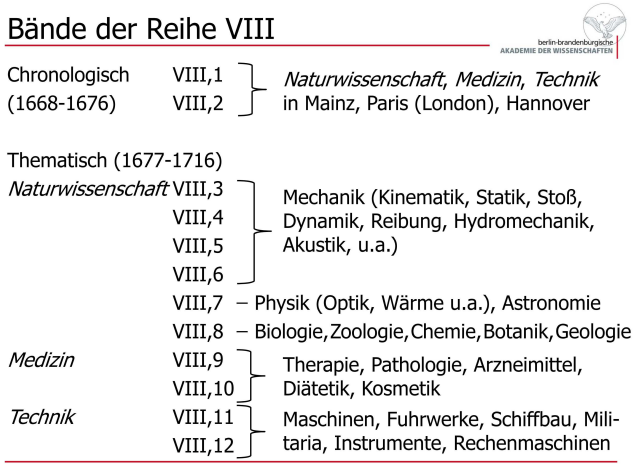

Figure 2. Distribution of the different subjects in volumes within the series VIII. (Source: Leibniz-Edition Berlin [http://leibniz-berlin.bbaw.de/forschung-aktuell/reihenplanung/view], reproduced with permission of Berlin-Brandenburgische Akademie der Wissenschaften)

This youth project to reform Cartesian physics did not see the light as a final work. In the many fragments dedicated to the problems of natural philosophy, Leibniz tackles the problem of the nature of the body from different perspectives. The solution he offered to this problem is presented in different ways depending on one or another period, as we will see in the next Section.

3. Constitution and Generation of Organics Bodies

Whether the body has a certain entity or is just a mere phenomenon is a classic problem in the literature on Leibniz (see Fazio 2017a and 2017b). His work contains fragments that defend one or the other thesis. In general, we can summarize them in the following way. In his youth, Leibniz was looking for an answer to the problem of the unity of the body which he developed from the idea of form. In this sense, the body has a certain entity when it has a form that is proper to it, that is, when it has an internal structure that explains its complexity and its way of reacting to external disturbances. This position will appear in later texts, for example, when he talks about the nature of chemical species or minerals. However, this thesis is surpassed by the one that Leibniz developed in his mature years and which refers to his theory of substance. As Leibniz tells us in central texts of his metaphysics, only the substance is provided with a formal principle that gives it true unity. This principle is the soul. The body is only a mere phenomenon whose unity is a product of the representation of the soul's activity. However, this thesis is nuanced in his *Monadology* at the end of his life. The monad is an active unit composed of an organic body (or organism) and a soul. In order to be active the monad not only needs to be incorporated into an organism, but this organism also needs to have a certain entity, that is, a certain activity that complements and makes possible the entity and the activity of the soul (which is also done in the opposite sense: the organic body needs the soul at the same time). We can interpret this idea along the lines of Kantian schematism: on one side we find the sensitive impressions, which depend on the particular constitution of the organism, and on the other side the world of understanding, present in the soul; both complement each other to generate the perspective of the world of a particular living being. Both sides are not only in harmony but depend on each other to give rise to the activity of representation that defines the monad. And both define the nature of the monad as a psychosomatic unit. Leibniz identifies this monadological conception of substance with the living being.

In light of the above, we find that in some texts Leibniz considers the organic body as a mere phenomenon, that is, a product of the soul's activity. However in other texts, Leibniz recognizes that the body must have a certain entity in order to be able to explain the active nature of the monad or corporeal substance. But what kind of entity belongs to an organic body? Here again we find two answers. On the one hand the organic body of a living being is considered by Leibniz as a composite body whose entity is explained from a theory of form equally valid for other compounds such as chemical species or minerals. This is the perspective that I have called constitutive or chemical. We find it in texts where Leibniz resorts to the chemical tradition

and the idea of *eductio* to explain the unity of the compound body. On the other hand, an organic body is defined by Leibniz in relation to its unity with a soul in a particular living being. I have called this perspective generative or biological and in which Leibniz follows the theory of preformation as defended by naturalists of the time to explain the natural generation of living beings.

Both perspectives are implicit when Leibniz defines in his *New Essays* his conception of the biological identity:

(a) the generative perspective that defines that two individuals belong to the same biological species if they can be included within the same reproductive line ('lineage' or 'species by generation'; see A VI, 6, pp. 293 and 309);
(b) the constitutive perspective, from which two individuals are of the same species when they have identical 'structure or inner constitution' (A VI, 6, p. 294) (in case of biological species this constitution refers to the set of organs that participate in a common life, A VI, 6, p. 231).

Under this double perspective, biological identity is something that is simultaneously transmitted from parents to children and something that confers an individual an organic body of a certain type. The first perspective, the generative one, constitutes a possible way to naturalize the idea of finality. The final causality is an inherent property of the same organic development without which we cannot account for the processes of natural generation (which are manifestly directed towards an end). The second perspective, the constitutive one, is in turn a way to naturalize the idea of form, which Leibniz understands as the structure or constitution of the organic body (its organism). The first way leads Leibniz to a vitalist position. However, unlike the vitalists, such as Stahl, Leibniz argues that it is not necessary to understand the soul as that intelligent force that governs the process of natural generation, introducing the purpose in organic matter. The second way leads him to mechanism. However, according to Leibniz the form does not identify with the mechanistic idea of figure – *i.e.* "the modifications of a thing that is truly passive" (Duchesneau & Smith 2016, p. 351). How then to understand the Leibnizian idea of organism? Is Leibniz making his way towards an alternative position that overcomes the mechanism-vitalism aporia?

Before answering these questions, we would have to deal with the problem of compatibility between the two understandings of an organic body. On the one hand, in the world of natural phenomena in which Leibniz locates all bodies including organic ones, the composition of both perspectives (generative and constitutive) must be fulfilled according to the principle of continuity (nature does not jump; *e.g.* A VI, 6, p. 56). However, on the other hand, considering the nature of the objects of study of both disciplines, biology and

chymistry, we find ourselves in front of a seemingly unsolved problem. Chymistry is a science whose objects of study are the 'chemical species' (as the term used by Leibniz). Although such species have a certain entity linked to a form or internal structure responsible for the reactivity that characterizes them, these chemical species are not real entities for Leibniz. Only living beings are proper entities, that is, substances (they are not merely reactive, but have an internal principle of action – the soul – that gives them autonomy). Therefore, an approach from the chymical perspective of the composition of bodies to the (biological) problem of natural generation seems incorrect. For Leibniz, the vital dimension of the living being, which resides in perception and appetite, is irreducible to the organic dimension, despite being in conformity or harmony with it. Although the understanding of the organic body of a living being could be approached by the chymical theory of the composition of bodies (I will come back to that later), an essential dimension to understand the singularity of the living body would still remain unsolved.

This would be a possible way to understand the Leibnizian idea of preformation, so that both perspectives, the chymical perspective of the composition of the bodies and the biological one of preformation will result compatible and complementary (one would extend it on the corporal dimension, the other on the soul and we would let the pre-established harmony do the rest, adapting *a priori* one dimension to another). The problem of the ambiguity of the organic body remains unsolved, but we would be able to define it in a certain way by following the strategy of the dual and parallel conception of the substance (body-soul).

However, what I would like to test is another reading. My interpretation is that both perspectives are not merely compatible against the background of ideas such as parallelism and pre-established harmony, but converge within the same heuristic project that has as its core the phenomenon of life in its multidimensionality: the organism, the vital unit or monad, and the organic body understood as aggregate of living beings. These three ideas cannot be understood independent of one another. Nevertheless, the main focus of this paper is on the idea of an organism.

4. What Is an Organism?

Historically, Leibniz is with G.E. Stahl and F. Hoffmann one of the first thinkers to speak of 'organism' (Cheung 2006, Andrault 2011a, Duchesneau 2014; Smith 2011, p. 98). They understand by organism the particular organization or machine that is the body of a living being. However each of these thinkers understands the organism from a different position. While Stahl ad-

vocates a vitalistic or animistic approach to this idea and Hoffmann interprets it mechanistically, it is not obvious that Leibniz understands it in any of these ways.

Throughout his work we find that Leibniz displays different definitions of the organism. On the one hand, he defines the organism through the idea of 'divine machine', *i.e.* "a machine to infinity" (*e.g.* GP VI, p. 618); and, on the other hand, through the idea of its unity with the soul or vital principle where perception and appetite resides (which is where, according to Leibniz, the life of the organism resides; see: GP VI, p. 539, A III, 7, pp. 945, 963; or Duchesneau & Smith 2016, pp. 33, 277)[2].

This disparity is responsible for the discrepancy that exists between the interpreters. Some of them follow a (more) mechanistic reading in line with Hoffmann's idea of organism (*e.g.* Duchesneau 2014 or Smith 2011). Others, instead, follow a (more) vitalist interpretation and emphasize that every organism is linked to a vital principle (the soul) with which they form a substance, a living being (*e.g.* Nicolás 2013, Cardoso 2009, Orio de Miguel 2002 and 2005)[3]. It is true that with both approaches Leibniz is in part reconciling the mechanistic and vitalistic view of the organism by delimiting the framework in which both views are valid (and partially redefining both positions). However, Leibniz not only had in mind to reconcile both positions, but to overcome and integrate them and offers his particular view as he does in other occasions.

Leibniz criticizes the mechanistic reductionism and its attempt to explain the organic body in terms of movement and extension. Faced with a mechanistic conception of the body, Leibniz argues that activity, formality, and finality are intrinsic qualities of each body (A VI, 4B, pp. 1558-1559, 1560-1561, 1564-1565 or GP IV, p. 472), without which we cannot understand the same unity and cohesion of the body or even its mechanical properties (A VI, 1, p. 491), as well as the organic machine (GP IV, pp. 48, 482) or the natural generation (GP VI, pp. 553-554).

Conversely, Leibniz also criticizes the vitalistic position. It is not necessary to introduce an immaterial and intelligent principle (such as the soul or God) to explain how the organic machine is capable of fulfilling the vegetative functions. This ability resides in the same active structure of the organic body, *i.e.* in its organism.

> I have referred this back to the force of vegetating, by which the living body perfects, nourishes, repairs, and propagates itself, and this, I maintain, follows from the very *structure of the machine,* […] the whole integrity of animal motion depends on a regular proportion between matter and the organs […] machines have ends and effects through the *force of their structure* […] From the fact that we are aware that the principle of motion is to be distinguished from the matter that is moved, it does not follow that the integrity of vital motion

> does not depend at all on the proportion of the matter and the organs. [Controversy with Stahl 1709-1711, ed. and trans. Duchesneau & Smith 2016, pp. 35, 39, 249, 299; my emphasis]

We can interpret from this quotation that the organism is the entity of the machine, a certain formal and dynamic entity. Leibniz defines this entity or organization that is the organism of a natural machine from the idea of the functional integrity of all its parts or organs which participate in a common life.

> PHIL. §4. What constitutes the unity (identity) of a single plant is having such an organization of parts in one … body [*i.e.* the organism], partaking of one common life, which lasts as long as the plant exists, even though it changes its parts. [*New Essays* 1704, A VI, 6, p. 231; trans. Remnant & Bennett 1996]

This functional integrity is linked to the idea of 'natural automaton' (*e.g.* GP VI, p. 618) with which Leibniz claims that the organism, unlike the artefact, is capable of self-production and conservation.

> […] divine machines [*i.e.* organisms] have this noblest feature beyond what is had by those machines that we are able to invent [*i.e.* artifacts], that they can preserve themselves and produce some copy of themselves, by which the operation for which they are destined is further obtained. [Controversy with Stahl 1709-1711, ed. and trans. Duchesneau & Smith 2016, p. 21]

> Nature moreover brings it about that her Machine is able to do this very thing on its own, that is, that it be able now to be nourished, whereby worn-down parts and forces are renewed, now to be itself moved toward the nutriments that are to be obtained and toward other means of sustaining its functions, as well as [away from] impediments that are to be avoided; now, finally, that it be warned by internal and external things, and that it be prompted toward the fitting motion. […] Machines are able to produce others of a nature similar to themselves. [*The human body, like that of any animal, is a sort of machine* 1680-1683, Pasini 1996, pp. 218-219; trad. Smith 2011, pp. 293-294]

It is in this idea of autonomy where the basis of the original Leibnizian conception of the organism resides as opposed to the mechanistic and vitalistic positions. In contrast to the vitalist position, according to Leibniz, it is not necessary to introduce any intelligent principle that governs the body: the 'vegetative force' resides in the same 'structure of the machine'. But neither this idea of 'structure of the machine', *i.e.* the organism, is reducible to a mechanical explanation. For the German philosopher this biological organization integrates a set of parts (organs) into a network of processes (nutrition, reproduction) aimed at an end: the preservation of the integrity of the living body. Leibniz intends in this way to highlight the operative sense and the internal aspect of the dynamism that gives the organism the *autonomy* that characterizes it and that makes it more than just a sum of parts.

Such an original position cannot be reduced to a mechanistic or vitalist conception. In fact, Leibniz develops a strategy similar to his conception of individuality and the individual (as an intermediate reality between substance and accident or subject and predicate) or his conception of force (where he articulates the ideas of power and act).

5. The Chymical Theory of Compounds and the Idea of *Eductio*

Leibniz's philosophy of nature and especially his theory of natural entities (minerals, metals, chemical species, but also organisms) is based on two fundamental pillars: the chymical-energetic corpuscularism of authors such as R. Boyle, R. Hooke, or P. Gassendi and the works on mereological structures of authors such as J. Jungius or J.A. Scherzer.[4] Leibniz looks at the chymical and mereological conception of the constitution of bodies as a way to overcome the deficiencies of mechanism related to the problems of the unity or cohesion of bodies and the origin of their qualities.

Following these authors, Leibniz starts from a conception of the body as a system of corpuscles, which is understood in mereological terms. What defines any corpuscular system is its internal structure or form. The form of a body (its 'natural form') is conceived as a principle of organization that integrates the totality of its parts and guarantees in this way the particular unity and cohesion of the body (its entity). This form also has a dynamic character (can transit between different states) and is responsible for the particular behavior of the body in the presence of environmental disturbances, *i.e.* explains all the qualities of the body (including mechanical ones: extension, movement, and figure). As each body is in turn understood as part of a major corpuscular system, its form and its qualities are the result of a dialectic where the complexity within the system (microcosmos) is a reflection of the complexity outside (macrocosmos) and vice versa.

Whilst Leibniz defends the infinite (and current) division of matter, scientific research does not aim at revealing the constituent atoms of matter, as opposed to the atomistic tradition. Rather, it is about revealing and classifying the forms or structures linked to the compounds and their particular reactivity (*i.e.* the set of their qualities). This chymical and mereological conception of the body offers an understanding of nature differentiated in infinite levels of complexity (Leibniz often speaks in this regard of 'infinite theaters'). The transition between these levels or theaters allows us to understand the emergence of new entities and phenomena. Leibniz refers to this image as

the 'labyrinth of the continuum' (A VI, 6, p. 225). A good example of this view of nature is found in his *New Essays*.

> PHIL. §11. If our senses were acute enough, sensible qualities such as 'the yellow color of gold', would then disappear, and instead of it we should see an admirable texture of parts. […] THEO. That is all true, and I said something about it earlier. But the colour yellow is a reality, all the same, like the rainbow. […] Lastly: if our eyes became better equipped or more penetrating [*e.g.* with the help of the microscope], so that some colours or other qualities disappeared from our view, others would appear to arise out of them, and we should need a further increase in acuity to make them disappear too; and since matter is actually divided to infinity, this process could go on to infinity also. [*New Essays* 1704, A VI, 6, p. 219; trans. Remnant & Bennett 1996]

It is not my aim here to go in depth and reconstruct this research program.[5] I will focus on the development and application of these ideas to the understanding of organisms. In a text that is titled 'On the ingredients and qualities of the bodies' (*De ingredientibus et qualitatibus corporum* 1678-1681; A VI, 4, n. 367[7], p. 2020) Leibniz analyzes the problem of the composition and decomposition of the bodies. There are two types of compounds, similar bodies ('*corpus similare*') and composite bodies ('*mixtura*'). In this second type of compounds, Leibniz includes the 'chymical species' and the organisms which display the following features:

(a) a set of starting compounds ('ingredients') which give rise to a new compound with a 'proper form' ('*figura propia*', '*characterismus*' or '*natura*') and which is not reducible to the sum of the forms of the starting compounds;
(b) any part that we take of this new compound is heterogeneous with the whole, *i.e.* the complexity of the compound is differentiated in its parts (this is essential for the parts to be able to play a role in the compound);
(c) the processes behind the emergence of these compound bodies are not a mechanical operation.

To illustrate these points, Leibniz gives the (counter-)example of a fabric. The form of a fabric, that is the result of a mechanical operation, is only the sum of the forms of the threads twisted, so that the resulting compound (the fabric) does not acquire a proper nature or form. On the contrary, during the chemical reactions that give rise to the production of new compounds emerges a new form or structure and a new series of properties or qualities linked to it. The examples Leibniz gives are chemical reactions: the decomposition of vitriol (sulphate in mineral form), the mixture of water and salt in the brine, or the case of the recovery of nitro (potassium nitrate). But this should

also apply to the case of natural generation of organisms (since organisms are included by Leibniz within this type of compounds).

Leibniz uses the Latin term '*eductio*' to refer to the *emergence* of forms and qualities that take place in this type of composition and decomposition of compounds. With this view he aligns himself with an emergentist tradition from the middle ages and early modernity as strongly influenced by the works of Alexander of Aphrodisia, specially *De anima* and *De mixtione* (see Pluta 2007, Mitrovic 2009, Kessler 2011, Blank 2017 and 2018). Exponents of these ideas that possibly had an influence on Leibniz could be the same Alexander of Aphrodisia, Galen, G. Mercuriale, Pomponazzi, or Taullerus (Leibniz cites works of all of them). The term *eductio* was used in the medieval and early modern natural philosophy to explain the emergence of the soul, the origin of qualities, the power of medicines, or the animal generation.

We will see below that Leibniz again makes use of the idea of *eductio* in the context of the problem of the natural generation of living beings.

6. The Problem of Natural Generation: Metamorphosis and Preformation

Leibniz's response to the problem of natural generation draws from two sources. On the one hand, the scholastic discussion about the origin of substantial forms or souls (GP VI, pp. 149ff.), and on the other hand, the criticism that his contemporaries made to Cartesian explanations about the generation of living beings (see Pyle 2006, pp. 198-201). Especially noteworthy in Leibniz's preformationism is the influence of W. Harvey, J. Swammerdam, and A. van Leeuwenhoek.

In relation with the first problem, Leibniz places some limitations on the theory of eduction in the context of natural generation. In his *Theodicy*, Leibniz develops a critique of the idea of eduction for the concrete case of souls or substantial forms.

> 88. Now philosophers have troubled themselves exceedingly on the question of the origin of substantial forms. For to say that the compound of form and matter is produced and that the form is only coproduced means nothing. The common opinion was that forms were derived from the potency of matter, this being called Eduction. That also meant in fact nothing, but it was explained in a sense by a comparison with shapes: for that of a statue is produced only by removal of the superfluous marble. This comparison might be valid if form consisted in a mere limitation, as in the case of shape. Some have thought that forms were sent from heaven, and even created expressly, when bodies were produced. Julius Scaliger hinted that it was possible that forms were ra-

> ther derived from the active potency of the efficient cause (that is to say, either from that of God in the case of Creation or from that of other forms in the case of generation), than from the passive potency of matter. And that, in the case of generation, meant a return to traduction. Daniel Sennert, a famous doctor and physicist at Wittenberg, cherished this opinion, particularly in relation to animate bodies which are multiplied through seed. […] 89. But traduction and eduction are equally inexplicable when it is a question of finding the origin of the soul. It is not the same with accidental forms, since they are only modifications of the substance, and their origin may be explained by eduction, that is, by variation of limitations, in the same way as the origin of shapes. But it is quite another matter when we are concerned with the origin of a substance, whose beginning and destruction are equally difficult to explain. [*Theodicy* 1710, GP VI, pp. 150-151; trans. Farrer 1985, pp. 170-171]

Leibniz uses an Aristotelian and scholastic terminology (see previous paragraph 87 of this work: GP VI, pp. 149-150) that differentiates between substantial and accidental form. In his opinion the soul or substantial form does not emerge from the potency of matter. On the contrary the figure or accidental form emerges from the potency of matter. It is not clear that the idea of organism as the 'proper form' or 'nature' of the organic body can be identified with a mere figure or accidental form, as we have seen in the criticism to the mechanistic conception of the natural machine. Of course, the organism is not a substantial form, it does not identify with the soul, but as we have seen from his criticism to Stahl's animistic position, Leibniz does differentiate between them.

For Leibniz, the substantial forms or souls of living beings were inserted by God at the moment of creation, which explains why he is against the idea that these forms educe or emerge from matter (GP VI, p. 151).

> […] as the formation of organic animate bodies appears explicable in the order of nature only when one assumes a *preformation* already organic, I have thence inferred that what we call generation of an animal is only a transformation and augmentation. Thus, since the same body was already furnished with organs, it is to be supposed that it was already animate, and that it had the same soul: so I assume *vice versa*, from the conservation of the soul when once it is created, that the animal is also conserved, and that apparent death is only an envelopment. [*Theodicy* 1710, GP VI, p. 152; trans. Farrer 1985, p. 172]

The idea here is not so much to save the immortality of the soul and to give a (marginal) place to the divine action, but rather to criticize the theory of spontaneous generation and the opinion of the Epicureans that the origin of the living being is the product of chance (Dutens II, pp. 132, 222). I would like to recall at this point two fundamental theses of Leibnizian thought. On the one hand, the principle of continuity: nature does not jump (*e.g.* A VI, 6, p. 56). This is the conviction that lies behind the rejection of the idea of God's intervention during the natural generation or against the theory of a

spontaneous or random generation. On the other hand, Leibniz claims that every living being, even the most insignificant, has a soul or is provided with some principle of organization or form (*e.g.* A VI, 4B, p. 1669) which is indestructible (*e.g.* GP VI, p. 151) and that ties in with the principle of continuity. What is organic or organized cannot come from what is inorganic or undifferentiated. Therefore, in the 'seed' that gives rise to the living being there must already exist some kind of organization from which the process of genesis will develop or unfold.

According to Leibniz's preformationism, both the organic body and the soul undergo a process of parallel and dependent transformation during the natural generation (and in general throughout the life cycle of the living being). What is *preformed* is the animal itself, *i.e.* the body-soul unity (GP VI, p. 619). Therefore, neither the soul emerges from matter, nor matter is informed by the soul. During the process of natural generation there is a harmonious, parallel, and dependency related development in the body-soul unity, *i.e.* the living being. The states of the organism cannot change (unfold or transform) without a change in the states of the soul; and *vice versa*. That is why Leibniz states that "the laws of mechanism by themselves could not form an animal where there is nothing already organized" (*Considerations on vital principles and plastic natures* 1705, GP VI, p. 544; trans. Loemker 1989, p. 589).

As far as only the organism is concerned, as a compound body (*mixtura*), we have seen in the previous Section that Leibniz considers it as a certain type of organization that *educes* from the complexity of organic matter, *i.e.* from 'something yet organized' (not merely from the potency of matter – we have seen how Leibniz distinguishes the type of form that is an organism from the mere figure). The generation of a certain organism is therefore nothing more than the development and transformation of structures or forms that emerge one from the other in the organic theater of nature.

7. Bridging Chymistry and Biology in the Study of Organisms

At the end of his life, Leibniz argues the following about the relationship between chymistry and anatomy in the study of animals:

> There is nonetheless a chemistry, so to speak, that is proper to animals, and so the changes that take place in the humors of animals belong no less to chemistry than those in the liquors of vegetables: indeed, *all bodies belong to chemistry when, following physical operations that consist in an invisible process, they are*

> *treated not as structures but as masses*. [Controversy with Stahl 1709–1711, ed. and trans. Duchesneau & Smith 2016, pp. 37-39, my emphasis]

By putting the object of chymistry in the masses, as indicated in his controversy with Stahl, Leibniz brings chymistry closer to medicine; whereas the structures, on the other hand, are properly the object of study of anatomy (Duchesneau & Smith 2016, p. 37). The analysis of the organic body of animals has to combine both anatomy, which studies its structure or organism, and chymistry, which studies all the processes that emerge in the organic mass and that are oriented towards the conservation of a certain organization. Chymistry 'brings out the organic' by revealing the 'invisible processes' on which the functions displayed by the organs depend. The organism is the principle of organization that integrates the whole of the organs around the fulfillment of a series of ends and, at the same time, the chemical processes involved in the deployment of its functions.

Both modes of approach to understand an organism are not only necessary but also dependent on each other. By understanding their relationship it will allows us, according to Leibniz, to advance in the field of pathology, pharmacy, or physiology.

Following these ideas, the constitution of an organism does not have to be understood in terms of a mechanical relationship between corpuscles but of a relationship between chymical processes in the masses that determine the folding, unfolding, and transformation of structures or forms which would lead us to the ideas of preformation and metamorphosis (*i.e.* to the generative approach) through which Leibniz explains the natural generation of organisms.

Therefore, from this definition of chymistry that Leibniz gives in one of his last works, the generative or biological understanding of the organism converges with the constitutive or chemical one.

8. Conclusions

Leibniz's discussion with physician G.E. Stahl represents a milestone in the history and philosophy of biology. For the first time the idea of the organism, a key concept in biological thought, is discussed. It is also done in the context of the debate between the mechanistic and vitalist positions, a debate for which we do not yet have a clear and unanimous answer. As I have shown, Leibniz's position in relation to this debate is also unclear. His conception of the organism cannot be identified as either mechanistic or vitalist, which makes it interesting, as it allows us to deconstruct this debate from a position that can lead to an original solution to the problem. As we have

seen, the various definitions we find in his work of this idea of organism are not easily compatible and in some cases they are contradictory, if not between them, then with other fundamental theses of his thought. In this paper I have shown how two of the definitions that Leibniz gives of the idea of organism, which at first seemed not very compatible, are convergent under the new definition of chymistry that he developed at the end of his life. If in his youth Leibniz understands chymistry from the corpuscularism of authors such as R. Boyle or P. Gassendi, being able to define it as a science of forms or combinatorics, his works on dynamics led him at the end of his life to consider chymistry from a non-corpuscular understanding of the body emphasizing the processes that are responsible for the corpuscular constitution of bodies (*i.e.* for the emergence, unfolding, development, and transformation of the formality that defines and differentiates them). This view which is valid for all natural entities becomes relevant in the case of organic bodies as it allows anatomy to be constituted as a specific science of organic formality, that is, of organisms.

In addition to allowing the convergence of chemical and biological understanding in the study of organisms, this view of nature agrees with the emergentist tradition that Leibniz echoes in the writing on composite bodies that I have analyzed here. In support of an eductivist or emergentist reading of the Leibnizian ontology and natural generation theory, we find that Leibniz himself uses the idea of eduction and that many of the authors that have been included in this emergentist tradition are quoted in his work. However, more thorough research is necessary. This reading could shed light on Leibniz's philosophy of nature and how it deals with the problem of the composition of the continuum.

The gist of the reading that I propose of the Leibnizian conception of the organism lies (1) in revealing the originality of Leibniz's position against the mechanistic conception of Hoffmann and the animistic one developed by Stahl; (2) in the convergence of chymistry and anatomy in the study of organisms as proposed by Leibniz in his latest works, which leads towards a non-mechanicist paradigm of understanding the natural machine. Chymistry is aligned with an ontology where nature is not understood from a discrete and mechanical perspective (as corpuscularism does), but from a continuous and processual one (if this model of ontology is hidden behind its Dynamics it is something that has to be investigated more deeply).

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Notes

1 I thank Paolo Rubini (Berlin Leibniz-Edition) for this information.

2 Leibniz provides throughout his work at least two other approaches to the idea of organism: as a living mirror or a mirror of the universe (in connection with his theory of expression; e.g. see GP VI, p. 618) and as an infinite succession of worlds of creatures (I have elaborated on this last idea in another work: Escribano-Cabeza 2020a).

3 For R. Andrault the idea of organism does not designate in Leibnizian thought any entity but a property of nature that fulfills an apologetic function: it regulates and limits, and is a condition of, the expression of an incorporeal principle (the soul and ultimately God) in the physical reality. See Andrault 2011b and 2016, chapter IV.

4 This aspect of Leibnizian thought, as well as the sources that I mention, have not been the object of much research yet and need to be studied more thoroughly (on this subject, see Burkhardt 2019, Mugnai 2017, Escribano-Cabeza 2017, Esquisabel 2008).

5 For a an in-depth analysis of Leibniz's chymical-philosophical thought see Escribano-Cabeza 2020b and Escribano-Cabeza 2020c.

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