François Duchesneau, *Leibniz, le vivant et l'organisme*, Paris: J. Vrin, 2010. 348 p.

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For some time, this reviewer has been championing the translation into English of François Duchesneau's many books on the natural philosophy of Leibniz. Greater availability of his work in the English-speaking world, along with that of Michel Fichant and, more recently, the contributions of Anne-Lise Rey, Raphaële Andrault, and Arnaud Pelletier, would in combination play a powerful role in helping scholars to form a richer picture of Leibniz's natural-philosophical model of the corporeal world, and of this model's centrality to his deepest and most mature philosophical project. With the publication of his most recent book, Duchesneau has reconfirmed the urgency of learning about this side of Leibniz.

The principal purpose of this review will be simply to summarize the recent book and to impart in a synoptic way the picture of Leibniz it draws for readers who may not have the time or capacity to work through the French text. If I am successful, this synopsis might then serve as an argument for the eventual publication of a translation. Following this, I will conclude by raising a few questions that I see as arising from this rich study, questions that might in turn serve as the germs of future research along the path Duchesneau has carved.

Duchesneau's book has six principal theses. First, he argues that Leibniz is committed to the need for a distinct philosophical account of the living being within the order of nature, as well as of the integrated and functional character of the micromachines that compose it. Second, Leibniz remains firmly opposed to all varieties of anti-mechanism, as well as to any analogous theory according to which mechanism is intrinsically inadequate to account for vital structures and functions. Third, Leibniz's reflections on the living world draw on his significant innovations in metaphysics and in physics. These refections may be seen as a sort of tributary of the transformation of the mechanics of force into dynamics, understood as the science of power and action. Fourth, Leibniz's methodological preoccupations are concentrated on figuring out how to promote an autonomous and specific science of living beings, along with a rational medicine or *medicina rationalis*. Fifth, Leibniz's science of dynamics makes it possible for him to attribute to the smallest organic machines an intrinsic power of action within a physical system governed by the laws of nature. Sixth and finally, at the same time as he is developing his notion of vital organization and of structural and functional integration, Leibniz believes it

is necessary to undertake an analysis of organic phenomena in the order in which they present themselves, which is to say that the science of life must be grounded in observation and experiment.

These are several weighty theses, but Duchesneau proceeds to defend them thoroughly and compellingly over the course of six chapters, each of which expands upon his earlier research on Leibniz and the life sciences.

In chapter 1, on 'Malpighi as Reference Model', Duchesneau describes more systematically than in earlier works the model that, he believes, dominated the sciences of life in the period. It is above all, he thinks, the Italian scientist Marcello Malpighi's conception of 'little machines' (*machinulae*) that exercises the most significant influence. Duchesneau convinvingly shows Leibniz's great debt to Malpighi's empirical program of 'subtle anatomy' (*anatomia subtilis*), which saw living bodies as made up of countless individual *machinulae*, in coming up with his own theoretical model of the infinitely nested structure of organic bodies. In recent scholarship, notably Ohad Nachtomy's *Possibility, Agency and Individuality in Leibniz's Metaphysics* of 2007, we have been offered a detailed account of Leibniz's model of organic nestedness and of the basis of his metaphysical conception of individuality in this model. But insufficient work had been done, prior to Duchesneau's most recent contribution, on Leibniz's debt to experimental science in general, and to Malpighi in particular, in coming up with this model.

Duchesneau maintains that Malpighi's variety of 'microstructuralism' was a major, if subsequently neglected, current of late-17th-century *philosophia naturalis*, and that it is crucial to investigate this current if we wish to understand the sources and aims of Leibniz's mature theory of the natural world. As is characteristic in Duchesneau's work, in his treatment of Malpighi the epistemological exigencies that lead to the proposal of a theory are emphasized as much as the content of the theory itself. In contrast with Descartes, who remained committed on *a priori* grounds to analogical models for the explanation of animal functions, Malpighi "confined his methodology to an analysis primordially founded on the correlation of observational data concerning the microconstituents of organic processes" (26). This led the Italian scientist to a theory of the hierarchical integration of corporeal machines, and one that could not be "easily rendered by a mechanical model that were to provide fully adequate sufficient reasons for the production of such an organization and of such an ordering of operations" in the living body (29). Ultimately, Malpighi is compelled to push the ultimate ground of the organization of these bodies beyond what Duchesneau describes as a 'transcendental' horizon, to

the extent that his machines of nature are formed from similar machines of nature *in infinitum*. This conception would in turn make its appearance in Leibniz's belief that there is no lower limit to the composition of bodies, that there are no ultimate elements beyond which analysis can in principle go no further.

Another important Malpighian doctrine which will find its echo in Leibniz holds that, whether or not a body has a soul in it, the soul must not be invoked to explain the activity of the body. Thus body and soul are, so to speak, parallel automata. This is for Malpighi an approach that is necessitated by a firm commitment to restricting science to the domain of observability. As he writes in the *Risposta del Dottor Marcello Malpighi alla lettera intitolata 'De recentiorum medicorum studio dissertatio epistolaris ad amicum'*, published posthumously in 1697:

> It is... certain that in vegetative, sensitive, and motor operations, the soul is necessitated to operate in conformity with the machine to which it finds itself applied, in the same way that a clock or a mill is moved in an equivalent fashion by a lead pendulum or a stone, by an animal or by a man; and even if an angel moved it, it would make the same movements with local displacement as do animals, etc. Thus, not knowing the mode of operation of the angel, but knowing the exact structure of a mill, I would understand the said motion and the said action; and if the mill were damaged, I would seek to repair its wheels and their defective composition, while omitting to investigate the mode of operation of the angel that moves it (*Opere scelte* 516; Duchesneau 44).

It would be impossible not to hear Leibniz's own words echoing when we read Malpighi's, both on the composition of organic bodies, as well as on the automatism of their action. Now, Malpighi's work on these topics predates Leibniz's, and Leibniz explicitly and repeatedly praises Malpighi in his own accounts of the structure of bodies and the source of their action. We have, in short, a knockdown case for the source of Leibniz's theory of organic body in Malpighi's microstructuralism.

Chapter 1 stands apart in this book to the extent that it focuses almost exclusively on Malpighi, rather than on the relation of the natural scientist to Leibniz himself. Yet the following three chapters thoroughly justify this initial focus, to the extent that they reveal to us Leibniz's own position within the microstructuralist school, and his indebtedness to his Italian predecessor.

In chapter 2, on 'Leibniz's Design for a Science of Living Beings', Duchesneau retraces the historical evolution of Leibniz's effort to build a science of vital processes. Of particular importance are Leibniz's early forays in this area, in the late 1670s and early 1680s, when he had not yet clearly defined the key elements of his

system of nature, in which natural machines would come to stand as the most basic elements of analysis. In these early attempts, Duchesneau writes, "from the point of view of method, Leibniz adhered to a microstructuralist approach that was very much in conformity with the Malpighian conception of physiology" (70). Without ever contributing directly to the scientific study of organic phenomena, texts such as the *Machina animalis* of 1677 or the *Corpus hominis et uniuscujusque animalis est machina quaedam* of the early 1680s (both given in translation as appendices to Duchesneau's book) stand as important methodological analyses that might supplement the positive scientific contributions of his contemporaries.

In this chapter Duchesneau pays particular attention to Leibniz's views on a methodological problem that, he believes, created a profound division among natural scientists and physiologists in the early Enlightenment, namely, the problem of "the relationship between the superficial order of phenomena and that of subordinate microstructures and microprocesses" (47-8). While following Malpighi's physiology, "Leibniz consistently adapts the conceptual schemes that he integrates to his own thought: this is what is produced in the context of his epistemological reflections... The scientific models from which he draws inspiration are mobilized in this way so as to derive from them a sort of theoretical conception of the living being" (70).

From the very first sketches of his interest in the science of living beings, particularly the *Directiones ad rem medicam pertinentes* of 1671, Leibniz expresses his agreement with those projects that seek to reconcile the systems of 'aphorisms', or anecdotal advice issuing from anatomical, physiological, and pathological observations, on the one hand; and, on the other hand, explanatory hypotheses that make it possible to apply mathematical reasoning to organic phenomena, as he believed scientists such as Nicolas Steno and Lorenzo Bellini were doing (50). To bring these two projects together, Leibniz thought it necessary to "study the series of determining reasons in the physico-chemical order that correspond to the order of organic phenomena" (52).

Over the course of the 1680s, Leibniz produces a number of methodological texts that develop what Duchesneau calls "the epistemological profile of the analysis of organic phenomena" (82). In these texts, Leibniz's most basic methodological objective is to ascend from effects to causes by way of analytic constructions that are as adequate to their objects as possible. These constructions should in turn be based on 'reasons drawn from geometry and from mechanics' (83). Leibniz's methodological approach, Duchesneau maintains, consists in "the construction

of explanatory models that transpose, in a geometrical fashion, the observable properties of bodies so as to represent the efficient processes that arise from their internal constitution" (83). This, Duchesneau concludes, is precisely the field of application of the precept, *omnia fieri mechanice in Natura* (83).

The central concept in the theoretical foundation of the conception of living beings is that of the *machina animalis*, first introduced in texts from the late 1670s and early 1680s. With this concept, Leibniz is concerned to account for the principle of motion of the machine, and he does so by appeal to the chemical fermentation that he believes underlies the mechanics of circulation and secretion (83). This, in turn, makes possible the whole range of processes in the living body that will eventually be explained by Leibniz in terms of the science of dynamics. In this account, as Duchesneau notes, the matter of the internal source of the power that is at the basis of this complex mechanism remains indeterminate. One might suppose that it is just this sort of indeterminacy as to the ultimate source of the vital motion and heat that led thinkers such as Stahl, with whom Leibniz would have a vigorous debate in 1709-10, to suppose that the soul must be invoked as the true and irreducible basis of life. For the Halle physician, to invoke chemical causes is only to push explanation back a level, but not to get behind the phenomena of nature whose causes one is seeking to describe. On Duchesneau's characterization, however, Leibniz's vital mechanics rests upon a formal cause that goes beyond the physical realm, while the organic machine is considered only as adequately 'symbolizing' this formal cause of action and integration, to the extent that its "structurally and functionally integrated cogs are able to constitute the objects of micromechanical analysis, which reveals their sufficient reasons in terms of their internal organization and their own dynamism" (84).

In chapter 3, on 'Leibniz's Machines of Nature', Duchesneau builds upon recent, important work of Michel Fichant, Pauline Phemister and others, investigating a number of interrelated questions having to do with the important conceptual innovation behind the mature Leibnizian concept of natural machine, which is, in the final analysis, exactly the same thing as the organic body. In particular, Duchesneau seeks to determine how the evolution of the theory of substance influenced the role of this concept within Leibniz's system of nature. He is also interested in determining what role we ought to ascribe to dynamics in Leibniz's conception of organism. Finally, he wants to know what the status of relations is between the different organic forms: relations which, in the end, are responsible for the individuation of corporeal substances.

One terminological issue much in need of clarification, to the extent that much of philosophical significance hangs on the correct use of terminology, is the meaning of 'organism' for Leibniz. Duchesneau rightly explains in this chapter that for Leibniz the concept of 'organism' refers not to living beings themselves, but rather to a particular form of organization and agency that characterizes natural machines (98-99). This form of organization is based, as Duchesneau shows, on a general accommodation by Leibniz of the mechanism of his contemporaries, with the modification that the analysis of the mechanism of natural beings cannot be carried out by our finite minds unless we make appeal, beyond mechanical explanation, to the final causality underlying the phenomena of vital organization, and unless we seek to understand how the order of natural mechanisms is grounded in the system of monads. The analysis of the natural machine in this chapter, very much like Phemister's account in her 2005 book *Leibniz and the Natural World: Activity, Passivity and Corporeal Substances in Leibniz's Philosophy*, shows the seamless connection between the monadic and the organic. Indeed, far from these being two incompatible ontologies in Leibniz's mature philosophy, Duchesneau shows how, by taking the natural machine as the starting point of analysis, and working back from secondary to primary matter, one easily sees that the organic body and the monad are for Leibniz two basic axes of analysis within one and the same system of nature.

In chapter 4, on 'Leibniz's Physiology as a 'Special Physics", Duchesneau investigates Leibniz's distinctive understanding of physiology, particularly in the mature period from 1695 to 1716. He is most interested in the epistemological and theoretical connotations of this usually very concrete notion, but also in its connection to certain precise investigations in the domain of *philosophia experimentalis*. Duchesneau holds that in his writings on physiology, Leibniz aims to promote a science that is as much in conformity as possible with the 'epistemological exigencies' of the complex metaphysical model of natural machines that he is in the course of elaborating (121). This objective, Duchesneau thinks, involves two convergent strategies: first of all, Leibniz offers a critical evaluation of the methodological stances taken up by the physicians and naturalists of his day; second, he spells out the sort of research that he would like to see succeed in the scientific circles to which he is closest. In other words, he attempts both to judge the merit of competing methodologies in natural science, as well as to positively influence, by way of proposals for research paths, the future course of natural science.

Duchesneau moves in this chapter through an investigation of Leibniz's contentious dispute with the physiologist Georg Ernst Stahl, to which we have already alluded, stressing the philosopher's frequent recourse to physico-chemical models in opposition to Stahl's antireductionist conception of the soul as mover of the body. He then moves on to consider Leibniz's efforts to bring together mechanism and empiricism in his correspondences with the Italian hydraulic engineer Giovanni Domenico Guglielmini and with the German physician and chemist Friedrich Hoffmann; the important influence on Leibniz of the mechanical physiology of Johann Bernoulli; and, finally, the role of the late-life correspondences with the engineer Bernardino Zendrini and the physician Pietro Antonio Michelotti in Leibniz's working out of an epistemological model for the representation of the functioning of natural machines.

In chapter 5, on 'Conti, Vallisneri, and Preformation', Duchesneau charts the impact of Leibniz's own theory of living beings on the science of his day, particularly in the work of Antonio Conti and Antonio Vallisneri, each of whom developed the kernels of a Leibnizian theory of generation into full-fledged programs. While the first chapter of the book had been principally about a figure who would be very influential in Leibniz's work, and while the following three chapters in turn focus principally on Leibniz himself and on his fruitful, two-way exchanges with contemporary natural scientists, this and the following, final chapter focus primarily upon Leibniz's own influence on the emerging life sciences of the early Enlightenment. Here the most important figures in immediate contact with Leibniz, who would in turn disseminate Leibnizian views far and wide among 18th-century natural scientists, include the disciple of Michelangelo Fardella, Antonio Conti, who authored the 1716 *Risposta del Signor abate Conte Antonio Conti, nobile veneziano, alla Difesa del Libro delle Considerazione intorno alla generazione de' viventi*; Antonio Vallisneri, the author of the *Istoria della generazione dell'uome e degli animali* of 1721; and, treated in the sixth and final chapter, Louis Bourguet, the author of the *Lettres philosophiques sur la formation des sels et des crystaux, et sur la Generation et le Mechanisme organique des plantes et des animaux* of 1729.

Both Conti and Vallisneri would develop theories of envelopment or *inviluppi* that may be traced directly back to Leibniz's theory of organic nestedness. The way in which Conti envisions the theory of envelopment, Duchesneau argues, may be understood as an original epistemological innovation, particularly with respect to the methodological requirements that he spells out for naturalists in search of a theoretical grounding for their observations (201). The Venetian philosopher

explains:

> In order to ground ideas and experiences, we subsequently construct hypotheses; but the hypotheses last until new phenomena modify them or destroy them, or until a more perfect art of comparing probabilities shows either their inutility or their superficiality (*Risposta* 65; Duchesneau 201).

For Conti, the theory of *inviluppi* goes together with a thoroughgoing commitment to the revisability of hypotheses. There is nothing natural or definitive about the current lower boundary of human perception: nature continues to be organized at levels of subtlety that our current instruments do not enable us to perceive, and as instruments improve, our accounts of the principles of the organization of nature will assuredly have to change as well. According to Conti, Duchesneau explains, the conjectures made "in the formulation of a theory of generation emerge from the comparative examination of principles that are able to justify systems that are distinct and, in varying degrees, opposed" (201). These principles do not have the status of *a priori* metaphysical precepts. Instead, they can at most be claims about truths of fact that may be called into question as a result of the discovery of new empirical laws (ibid).

Leibniz and Conti exchanged letters toward the very end of Leibniz's life: in a very different guise, Conti would also play an instrumental role in the controversy between Leibniz and Newton. Leibniz's relations with Antonio Vallisneri, in turn, were significantly inflected by the latter's relationship to Louis Bourguet, with the three men enjoying a rich, three-way correspondence towards the end of Leibniz's life. According to Duchesneau, the references to Leibniz in Vallisneri's *Istoria* reveal the German philosopher's crucial role as an inspiration for the work. This inspiration may be traced back at least to 1714, when Leibniz sent a sort of plea to Bourguet, intended to influence the Italian scientist:

> I very much wish that the great question of the generation of animals may be advanced, which has an analogy with that of plants. Monsieur Camerarius of Tübingen believed that the grain was like the ovary, and the pollen (although in the same plant) like the sperm of the male. But if this were true, the question would still remain whether the basis of the transformation or the preformed living being is in the ovary, following M. Vallisneri, or in the sperm, following Leeuwenhoek, for I maintain that one always needs a preformed living being, whether plant or animal, which is at the basis of the transformation, and that the dominant monad itself be there: no one is better suited to clarify this doubt than M. Vallisneri, and I very much hope to see his dissertation soon; his dedication

would do me more honor than I merit (GP III 565; Duchesneau 202).

Vallisneri will attempt to satisfy Leibniz's request. Among the competing theories of generation, Vallisneri will come down firmly in favor of preformation, justifying this commitment not by appeal to any conclusive conceptual or experimental proof of preformation, but only in view of its greater probability. Experimental philosophy of the sort practiced by Vallisneri, Duchesneau explains, limits itself to the description of phenomena and the establishment of empirical laws. To pass to a higher order of explanation requires hypotheses that either depend upon an analogical extension of experimental data, or take recourse to principles of reason, such as the principle of continuity (210-212). For Vallisneri, the choice of any given theory of generation can only ever be a matter of comparing the relative probability of hypotheses.

In chapter 6, finally, on 'Bourguet and the New Model of Organic Bodies', Duchesneau considers the appropriation of the Leibnizian theory of organic bodies and monads within one significant natural-scientific model of what would later come to be called the 'biological' world. He shows how the question of delimiting the organic from the inorganic runs through the work of Louis Bourguet, whose conception of 'organic mechanism' in his 1729 *Lettres philosophiques* effectively initiates the application of the Leibnizian model within the life sciences in the period of the early Enlightenment.

Bourguet offers an interesting and influential variations on the Leibnizian model of the organic body and the natural being of which it is the vehicle. His original contribution in his *Lettres philosophiques*, Duchesneau thinks, consists in the fact that he pushes to its extreme the search for a reductionist explanation of vital activity. This reductionism, at the same time, is combined with the postulation of preexisting organic structures that may undergo not only growth and development, but indeed true transformations determined by the interaction of connected causes of a physico-mechanical nature. Preexisting germs are thus conceived less as complete, miniature organisms than as 'organized matrices', of which the subsequent transformation is brought about in a regular fashion by means of an 'organic mechanism'. Bourguet explains that:

> *Organic mechanism* could only take place in a body that is already organized, and ... it is a fundamental axiom in this matter that one must necessarily admit *preexisting organic bodies* before the organic mechanism is able to enter into operation. It is not difficult after this to conceive that the same mechanism that operated in the large body is able to be communicated to the small body that it

encloses (Bourguet 146-47; Duchesneau 286).

In this chapter as in the preceding ones, Duchesneau moves fluidly from the content of the theory in question to the epistemology and methodology motivating the thinker under discussion to propose the theory. He explains that, in Bourguet's view, hypotheses should be challenged to explain the most complete set of generic phenomena that correspond to the function at hand, and that it is with this objective in view that the French scientist rejects the hypothesis of 'organic molds' and of plastic natures, while defending that of development from preformed structures (294).

Bourguet represents a fascinating alternative path for the possible history of Leibniz's reception, one that was cut short with the recruitment of this pan-European philosopher, long after his death, into the German Idealist tradition. In the French natural science of the years immediately following his death, it made perfect sense to use Leibniz's work as a starting point for the construction of theoretical models meant to explain the structure and motion of bodies, in particular living bodies, in the natural world. Duchesneau's interest in recuperating a vision of Leibniz's legacy such as that represented by Bourguet, not surprisingly, yields an interesting and somewhat lamenting perspective on the state of much current Leibniz scholarship. He makes reference early on to the "great debate that is currently driving Leibniz studies" (16), the one, namely, as to the status of corporeal substance in Leibniz's metaphysics, and lucidly diagnoses it as an artefact of a certain preoccupation guiding scholars writing in a certain prominent language. The debate, he writes,

> originates in the interpretations that have long dominated in Anglo-American milieux, according to which Leibniz's metaphysical system, in its canonical formulations, notably those of the mature period, is held to have supported an idealistic account of the nature of realities exterior to the mind: the bodies of the physical universe are held to be reducible to the status of phenomena for the subjects of apperception and reflection constituted by our minds (ibid).

For Duchesneau, it is certainly true that "Leibniz maintains that every monad carries with it indissolubly an organic body that corresponds to it," and that "every monad, soul or mind, along with its own body conjointly constitutes a composite or corporeal substance." Nevertheless, "these so-called composite substances could not be conceived as possessing their own reality independently of the representation that the monadic subject procures for itself through the external projection of its own internal states." From this arises "the presumption that the

so-called realist claims concerning composite substances, organic bodies, and the material foundation of movements in the physical universe could only be relative expressions, in need of translation into the lexicon of phenomena as well-founded mental representations" (ibid).

This "idealist revision of the Leibnizian system," Duchesneau thinks, "suffers from a retrospective projection of later philosophical categories onto propositions that are clearly made within the context of natural philosophy (*philosophia naturalis*): these propositions should in fact be understood as encompassing in a single vision the order of bodies and that of their monadic substrata" (17). This is possible in view of the insertion into the definition of the monad the notion of primary matter or primitive passive force, whose exact role in the metaphysics of composite substance Duchesneau will go on to treat with insight and clarity at several points throughout the book. It is, Duchesneau thinks, from the qualitative combination of intrinsic force with resistance in metaphysical atoms, or the primordial elements of reality, that the determining ground of composite substances, underlying the phenomenal order, flows.

So Leibniz's various accounts of monads and bodies are not at all, for Duchesneau, the result of an attempt to find his way towards one side or the other of the rift between idealists and realists, nor are they the result of an attempt to navigate his way through two opposite and unharmonizable poles. They are rather the drafts of a system that is explicitly meant to account for all levels of reality. Duchesneau claims --and I note here that I have never seen the defense of the 'realist' Leibniz put in quite such bold terms-- that "Leibniz could not have had purely metaphysical aims. The most fundamental philosophical project for him is that of producing a system of nature" (20). He goes on to ask:

> Does not the expression appear, after all, in the title of the major work published in 1695, the *Systeme de la nature et de la communication des substances, aussi bien que de l'union qu'il y a entre l'ame & le corps*? And one could speculate similarly as concerns the titles of the two works of 1714, the one bearing the phrase 'philosophy of nature', the other 'principles of philosophy', which no doubt was meant to suggest to his contemporaries a reference to the model established by the *Principia philosophiae*, in which Descartes laid out his system of nature (20-21).

Here one might make the minor objection that in the title of the 1695 work, at least, 'nature' refers not to the order of the world, but rather to the internal character of individual substances. Thus the title that *we* ordinarily abbreviate as 'System of

Nature' does not really name a work that its author intends to identify as belonging to the genre of *systema naturae*. This small point aside, however, Duchesneau is certainly right to identify much of Leibniz's work as belonging to the system-of-nature genre, and to see his metaphysics as only one part of his project, however incomplete, of contributing to this genre. The usual understanding has it exactly the other way around: it takes the natural philosophy as secondary to the metaphysics. But the only justification for this is our perception of Leibniz as principally a 'philosopher', and our consequent attribution to him of a range of concerns that would only later come to be associated with this job description.

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