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*Divine Machines: Leibniz and the Sciences of Life* by Justin E. H. Smith

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Justin Smith's fine book opens with a subtle guide for the reader. The preface claims that Smith sees *Divine Machines* as a 'transitional fossil'. In an age of increasingly electronic, interdisciplinary, collaborative research, Smith acknowledges that a single-author, printed book is already something of a fossil. However, *Divine Machines* is a transitional fossil because it employs these methods in a form that belies the virtual connections and electronic resources that made it possible.

In *Divine Machines*, G. W. Leibniz (1646–1716) is treated as a transitional fossil, and this is to his credit. It is clear that Leibniz is a thinker-in-between for Smith. The opening pages situate him between Aristotle and Nietzsche. The body of the book holds Leibniz's 'forward-looking' metaphysics and mechanism together with the problems that he inherited in natural philosophy and theology. The task of this book is to make sense of this shifting ground.

Methodologically, this puts Smith's work in a growing field of scholars who see Leibniz as a dynamic thinker rather than as a representative of a fixed philosophical system. The result is an investigation into the chronological development of his engagement with the life sciences—from an early concern about the reform of medicine to later views about the organic structure of the world [15]. The innovation in Smith's text is to locate Leibniz's engagement with the organic world and his emerging life sciences at the center of his dynamic thought. In particular, he treats the problem of the structure and motion of the physical world, living entities, and lifeless things [parts 1–2]; the problem of coming into being or generation [part 3];

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and, species [part 4] as biological problems rather than as linguistic ones.

This stands in contrast to recent literature in Leibniz scholarship which has been largely concerned with interpreting Leibniz's metaphysics on an idealism/realism spectrum. In contrast, Smith aims to change the terms of the debate by refocusing it on the phenomena of life and by re-conceiving Leibniz's theoretical concerns in fundamentally biological terms [6]. The picture of Leibniz that emerges is more empiricist than often assumed, and it focuses on the structure and organization of bodies rather than the ontological status or ground of bodies. On Smith's reading, Leibniz is a philosopher of life whose philosophy is 'of biology' in important ways; but these have been mostly neglected, until now.

Smith also recognizes that Leibniz's philosophy of biology is a philosophy of medicine. As such, his argument begins by taking seriously Leibniz's early and formative encounter with medicine. Here, as throughout, Smith is able to bring together aspects of Leibniz's wide-ranging interests and he provides very helpful, broad introductions to often neglected areas of Leibniz's thought. The analysis is contextualized both by current scholarship on Leibniz and views contemporaneous with Leibniz.

In chapter 1, Smith shows that Leibniz's early encounter with medicine began a lifelong engagement with the medical debates of his day. This area of Leibniz's thought draws together experimental methods from vivisection to microscopy, influences from chemistry, commitments to improving public health, and the overarching concern to understand the mechanics of animal bodies. The opening chapter on medicine complements the remainder of the book. In particular, Leibniz's medical texts provide a snapshot of a larger shift in Leibniz's thought. In medicine, Smith charts Leibniz's gradual movement from an interest in the macroscopic vivisection of animal bodies to the microscopic investigation of what these bodies contain, including microorganisms. The chapters that follow parallel this shift. They trace the development of Leibniz's understanding of animal bodies from the macrostructure and function of the 'hydraulic-pneumatico-pyrotechnical' machine of animal economy to the microstructure and organization of the 'machines within machines to infinity' of organic bodies.

In chapter 2, Smith provides a detailed description of Leibnizian animal economy. On his reading, animal economy is part of Leibniz's early attempts to describe the animal body as a special kind of machine. The key feature of this discipline is its intention to understand animal bodies as a structure that is economical in the sense of achieving the maximum effect with the minimum of organs and in the sense of providing explanations of vital phenomena without recourse to the soul [92–93]. Animal economy is important in Leibniz's thought as the initial stage of his lifelong project of understanding the mechanism of animal bodies. Smith argues that Leibniz's focus shifts from this initial interest in the macrostructure of animal economy to the microstructure of the organism of the body. The latter is the subject of the remainder of the book.

For Leibniz, 'organism' is a structural term that names a condition of organic bodies; its meaning is closer to organization than to a biological entity, although the two are related. As Smith writes:

Organism is to natural machines what mechanism is to artificial machines, and this organism is not contrasted with mechanism, but rather is conceived as a variety of it. [106]

'Organics' is the term used to describe Leibniz's attempt to describe animal bodies as infinitely complex, natural machines. By emphasizing Leibniz's pervasive interest in organics, Smith is able to trace another overlooked development in Leibniz's thought. In addition to the shift in focus from the macrostructure to the microstructures, Smith's persuasively argues for a change at the level of the structure of bodies 'from finite structures decomposable into homogeneous masses, to infinitely structured machines, or bodies endowed with organism' [105]. In the course of this argument, chapter 3 provides a clearly articulated conceptual map of the items that populate Leibniz's natural world, including organic bodies, artificial and natural machines, corporeal substances, animals, and aggregates.

Organic bodies are distinct from mechanical bodies because they are infinitely complex [108]. On this view, organic bodies are distinguished from mechanical ones without the introduction of an immaterial vital principle. The difference between inorganic and organic is in complexity. By locating the difference at the level of complexity, Leibniz maintains his thoroughgoing mechanism. At the same time,

organic bodies are conceptually distinct from the corporeal bodies within which they are always found.

In this discussion, Leibniz is a ‘transitional fossil’. As Smith writes:

Leibniz helps to open up the possibility of studying biological entities biologically, that is, independently of soul-based features such as unity and activity. This new possibility would ultimately help to stimulate a naturalistic conception of biological entities, which in turn, would come to underlie the newly independent science of biology: the study of vital phenomena without appeal to vital forces. [110]

Organics helps to isolate a feature of the natural world which can be investigated without recourse to vital forces. There is some debate as to whether this is appropriately understood as a naturalistic conception but the distinction Smith identifies and its importance are well argued. With this distinction in hand, Smith helpfully compares his reading to contemporary scholarship on Leibniz and Leibniz’s view to positions contemporary to Leibniz himself, including in his remarks Henry More, Anne Conway, Ralph Cudworth, and Damaris Masham.

Chapters 4 and 5 turn explicitly to the scientific and theological contexts of Leibniz’s theory of organic bodies. In the former, Smith examines Leibniz’s innovative theory of nested individuality and his long engagement with microscopy; in the latter, Smith develops Leibniz’s account of divine preformation. This combination of influences explains the title of Smith’s book. Organic bodies emerge as infinitely complex machines that are neither naturally generable nor corruptible. Only God can bring them into existence or take them out of existence. As such, Leibniz argues that together organism and divine preformation are sufficient to explain the origins, structure, and motion of organic bodies. Hence, organic bodies are divine machines:

divine, because initially generable only by God directly; machines, to the extent that one need take no recourse to God’s constant concurrence, nor to some subordinate God-like principle within the machine, in order to obtain an adequate understanding of it. [135–136]

With this understanding of Leibniz’s theory of organic bodies, the final chapters of *Divine Machines* address two well known features

of Leibniz's thought: spontaneity and species. In his treatment of spontaneity, Smith distinguishes between two early modern options:

- (1) spontaneity in which states are determined solely by the intrinsic properties of the thing itself, and
- (2) spontaneity in which states are undetermined by prior conditions and arise under the influence of mind-like powers without constraint by the material being influenced.

Leibniz makes the former a central piece of his philosophical project; he rejects the latter. Smith connects Leibniz's view of spontaneity to his theory of trait acquisition and generation in the emerging life sciences and to his explanation of fossils in the emerging geological sciences. Supported by his preformationism and pre-established harmony, Leibniz opts for a view of generation as heterogenesis and sees fossils as vestiges of organic bodies rather than 'games of nature'.

In the final chapter, Smith takes up the question of Leibniz's view of species and he finds that for biological species Leibniz is a species-fixist. Consistent with his view of preformationism, Leibniz holds that the natural species are fixed from the time of creation, even as they may undergo radical changes over the course of a lifetime. These commitments together make Leibniz a species realist and not a nominalist. In this debate, Leibniz's primary interlocutor is John Locke; but Smith helpfully contextualizes these discussions with Leibniz's contemporaries by engaging John Ray, Nathaniel Highmore, Anne Conway, Edward Tyson, and others. Smith argues that Leibniz views biological species membership as determined by generation and origin. Smith's approach allows him to include Leibniz's denial of the possibility of evolution and his universalist anthropology as relevant features of his view of species.

Again in these final chapters, the reader gets a sense of Leibniz as 'transitional fossil'. He offers a thorough-going mechanism that is at the same time replete with immaterial powers/forces. He recognizes transformative morphological change but denies the principle of evolution. The fact that Smith is able to chart this shifting space with such precision is one reason, among many, to recommend *Divine Machines*. In addition, the concluding appendixes make available in English a chronological sample of Leibniz's texts on medicine, animals, and botany. Most importantly, Smith integrative approach to

Leibniz's philosophy and his lifelong engagement with the emerging life sciences brings a new lens to early modern scholarship.

In some cases, this raises challenges. For example, in the discussion of species, Smith considers Leibniz's view of the great chain of being, which is understood as the continuous, hierarchical ordering of nature. Typically, this view is read as supportive of a nominalist reading of species. However, Smith claims that Leibniz can hold together the commitment in the infinite gradations between natural kinds and the possibility of real breaks in the continuum. These breaks provide a view of nature that is dense rather than continuous and, as such, it is supportive of Leibniz's species-realism. In this instance, Smith's argument does not settle the matter. The claim against Leibniz's nominalism in favor of species-realism is persuasive but it opens up a deeper debate about whether Leibniz can consistently hold a view of nature that is in some sense both dense and continuous. Even in the instances where the reader's doubts linger, Smith's scholarship makes a convincing case and one is required to look anew at Leibniz's most well known commitments. For the contributions it makes in our understandings of Leibniz and for the way in which Leibniz is integrated in the emergence of the life sciences, *Divine Machines* is highly recommended reading.