Models of organic organization in Montpellier vitalism

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Abstract

The species of vitalism discussed here is a malleable construct, often with a poisonous reputation (but which I want to rehabilitate), hovering in the realms of the philosophy of biology, the history of medicine, and the scientific background of the Radical Enlightenment (case in point, the influence of vitalist medicine on Diderot). This is a more *vital* vitalism, or at least a more 'biologistic', 'embodied', medicalized vitalism. I distinguish between what I would call 'substantival' and 'functional' forms of vitalism, as applied to the eighteenth century. Substantival vitalism presupposes the existence of something like a (substantive) vital force which either plays a causal role in the natural world as studied by scientific means, or remains a kind of hovering, extra-causal entity. Functional vitalism tends to operate 'post facto', from the existence of living bodies to the desire to find explanatory models that will do justice to their uniquely 'vital' properties in a way that fully mechanistic models (one thinks e.g. of Cartesian mechanism) cannot. I discuss some representative figures of the Montpellier school as being functional rather than substantival vitalists, particularly as regards the models of organic organization which they develop, and make some suggestions as to how these relate to the then-nascent science of biology.

1. Introduction

There are different ways to approach the topic of vitalism today. It can be treated as a metaphysical theme, typically with reference to authors such as Henri Bergson and Georges Canguilhem (the latter also as a historian of medicine).[1] Here, the vitalist is a thinker focusing on activity, dynamism, creative power, or perhaps the dialectic between health and sickness, including as a metaphorical way of conceiving of the social body as a whole. Or vitalism can be contextualized within a 'historical epistemology' of the life sciences, yielding historical distinctions between Montpellier vitalism (associated with prominent eighteenth-century doctors and professors at that faculty); a more embryology-based vitalism in Germany with Johann Friedrich Blumenbach and Hans Driesch in the nineteenth and early twentieth

[1] On vitalism in early twentieth-century thought, see Nouvel ed., *Repenser le vitalisme*, and Wolfe & Normandin, eds., *Vitalism and the Scientific Image, 1800-2010*.

centuries[2], but also, the medically tinted doctrines of figures such as Diderot, whose obsession with 'living matter' or, at times, with the metaphysical thesis that *all of* matter was living matter, leads him to be understood in a context of affinity with medical vitalism.[3] In the latter case, vitalism is the name for a theory that seeks to do justice to the specificity of certain types of entities in a more naturalistic context; these entities can be variously defined or polarized as living versus dead bodies, physiological versus anatomical objects of study, organisms versus machines, and so on. In addition, the word 'vitalism' is also used in various theory-oriented discourses in the humanities, in a markedly unclear and undefined manner.

The situation is similarly tense in the disciplines seeking to articulate theoretical reflection on biology, including the philosophy of biology. Here, vitalism is typically understood as the view at the utmost margins of the development of modern biology, that life is somehow to be understood as possessing a mysterious 'vital force' or 'vital principle', apart from the causal, experimental world studied by natural science. In that sense the term 'vitalism' is still badly in need of clarification and typological effort, given that writers close to the biological sciences use it to mean a kind of supernaturalism, while theorists in the humanities speak liberally of textual vitalism or the vitality of immateriality, while historians of the life sciences can quarrel over the differences between, e.g. medically or chemically based vitalisms, embryologically based variants and of course versions which fuse genres such as the 'vital materialism' of a Diderot. As we will see below, even approaches which are much more sympathetic to a 'non-reductionist' impulse in recent biological developments (with a focus on development, or evolutionary processes, or systemic concepts) still try and steer a safe path around the metaphysical dangers of vitalism.

Faced with this attitude, the historian-'épistémologue' of the life sciences can simply retort that it is mistaken on the basis of precise historico-theoretical 'facts': that the context in which the word 'vitalism' was first used, in the later eighteenth century in the Faculty of Medicine at Montpellier, as a self-description referring to half a century's worth of medico-theoretical writings, shows none or hardly any signs of 'vital force' concepts.[4] Similarly, with respect to the case of the influential German embryologist J.F. Blumenbach in the late eighteenth and early nineteenth centuries: even his 'vital force' concept, the well-known *Bildungstrieb* is much closer to mechanism, and is understood as a Newtonian-type unknown

[2] Blumenbach, *Über den Bildungstrieb*, Driesch, *Der Vitalismus als Geschichte und als Lehre*; see discussions in Duchesneau and Cimino, eds. *Vitalisms from Haller to the cell theory*, and Wolfe and Normandin, eds., *Vitalism and the Scientific Image, 1800-2010*. On the debates on vitalism in nineteenth-century chemistry deriving from Wöhler's synthesis of urea as an incentive for careful historical typology of this idea, see Benton, "Vitalism in nineteenth-century scientific thought: a typology and reassessment."

[3] Kaitaro, *Diderot's Holism*. I speak of a 'historical epistemology' of vitalism rather than strictly of its history (including intellectual history) because I focus on its epistemic constructions in order to both emphasize their specific historicized nature (thus the medical vitalism of Enlightenment Montpellier is not the embryology-based vitalism of Hans Driesch in the late nineteenth century, and neither of these bear much resemblance to what historians of early modern philosophy call 'vitalism' in figures such as Margaret Cavendish in the seventeenth century, etc.) and their conceptual status (is a 'functional vitalism', as I discuss below, a viable heuristic approach to the nature of living beings?).

[4] Rey, *Naissance et développement du vitalisme*; Williams, *A Cultural History of Medical Vitalism in Enlightenment Montpellier*; Wolfe and Terada, "The Animal Economy as Object and Program in Montpellier Vitalism."

without 'substantial' existence of its own.[5] Haller's physiology of fibres is in the background: a sophisticated mechanism, but already one stressing irreducible 'vital' forces such as irritability. Blumenbach's *Bildungstrieb* grows out of this context: not an a prioristic ontological vitalism but a sophisticated inductive model positing forces to explain observed phenomena.[6]

A fully historicist approach to vitalism then produces a multitude of different forms – different epistemic norms, ontological commitments and scientific contexts: a vitalist invoking as her empirical evidence, the growth of the embryo, will produce quite a different theoretical claim than the vitalist who invokes the integrity of the 'whole person' in medicine, or the chemical properties of living matter versus 'inert' or 'brute' matter. But there remains a problem. If there is any overarching conceptual unity at all to the concept, what *is* vitalism calling for, if not for mysterious vital forces? That is, it may be a weak answer to simply say: there are many forms of vitalism and the 'vital force' form is just one of these. And further, is it possible in any sense to understand its posterity in the life sciences, given the successive attempts to eliminate it? For the hostility to a 'mysterious' vitalism is not just the invention of twentieth-century critics (whether motivated by genetics, or a generation earlier, by physics-based arguments appealing to the causal closure of the physical world, in the Vienna Circle, with thinkers like Moritz Schlick[7]). It is present, one might say, constitutively, from at least the eighteenth century onwards.

Physiologists, physicians and other figures in the orbit of what comes to be called 'biology' in the same period fight a peculiar battle for disciplinary identity and especially legitimacy, in tension with what we might think of as a metaphysics of life, or a type of scientific practice supported by a metaphysics of life. Indeed, it is perhaps no coincidence that tensions surrounding 'vitalism' as an offending object to be removed, and efforts at conceptual clarification of the scope of a science called 'biology' seem to come hand in hand, from the later eighteenth century to the mid-nineteenth century, whether it is Albrecht von Haller attacking the excessively metaphysical concept of irritability in Francis Glisson, Xavier Bichat attacking the Montpellier vitalists for not having being sufficiently experimental, while he propounded his own 'vitalist' concept of the two lives, or Claude Bernard who applied to Bichat the 'medicine' he had given to his own predecessors, tarring him with the brush of vitalism. Bichat says that the Montpellier physicians "considered science philosophically; they would have made greater [scientific] progress if they had known more anatomy – Haller

[5] On the heuristic value of 'Newtonian unknowns' in eighteenth-century life science see Hall, "On Biological Analogs of Newtonian Paradigms," and Wolfe, **"**On the Role of Newtonian Analogies in Eighteenth-Century Life Science."

[6] In a series of writings (most recently, "Blumenbach on Teleology and the Laws of Vital Organization"), François Duchesneau has shown how Blumenbach's vitalism influenced the longer-term elaboration of serious functional models in biology, including the study of the mechanisms of development, *Entwicklungsmechanik*. For further research into the constitution of biology in this Germanic context, see Gambarotto, *Vital Forces, Teleology and Organization*.

[7] Moritz Schlick, "Philosophy of organic life" (an excerpt of a longer essay on *Naturphilosophie* for a 1925 philosophy handbook, Max Dessoir's *Lehrbuch der Philosophie*).

only made such great progress for that reason."[8] Bichat's doctrine of the 'two lives' was presented by Bernard as running counter to his own rigorous, 'deterministic' and monistic scheme: for Bernard, however much there may be features unique to the "living machine" (*machine vivante*), nevertheless, "the chemistry of the laboratory and the chemistry of life are subject to the same laws: there is no such thing as two (separate) chemistries."[9] (Yet Bernard ends up conceptualizing vital properties as well…) In that sense, vitalism is not just one theory among others that can be refuted or eliminated in the course of the history of the life sciences (like, say, preformationism). It is also a component in struggles for definition of an experimental life science that also involve demands for the autonomy of such a science.[10]

Vitalism is then a concept, or better, a family of concepts – indeed, ones lacking a strictly conceptual presentation, as they are above all *attempts* to grasp the specificity of living systems, which then allow of more or less articulated conceptual reconstructions[11] – implicated in a series of tensions and quarrels for legitimacy in the self-definition of the biomedical sciences. In addition, it seems to come in more or less metaphysical forms. We then need to achieve some conceptual clarity regarding this diversity, and to inquire into its metaphysical status. In what follows, I return (in sections 2 and 3) to what I see as the primary distinction between 'forms of vitalism', namely, substantival versus functional forms of vitalism, with particular focus on eighteenth-century Montpellier vitalism, and (in section 4) comparing this episode with Georg-Ernst Stahl and Hans Driesch, also as regards the models of organic organization on display. I conclude in section 5 with more general reflections on the posterity of vitalism in life science, and, again, the nature of organism or "animal economy" understood as a type of organization.

2. Forms of vitalism

[8] X. Bichat, *Discours sur l'étude de la physiologie*, included in Bichat, *Recherches physiologiques sur la vie et la mort*. Bichat explicitly identified Barthez's vital principle with Stahl's anima and Van Helmont's archaeus (Rey, *Naissance et développement*, 361); Broussais claimed that Barthez "founded medicine on his readings rather than observations" (Broussais, *Examen des doctrines médicales* (1821), quoted in Lavabre-Bertrand, *La philosophie médicale de l'école de Montpellier au XIXe siècle*, 89).

[9] Bernard, *Introduction à l'étude de la médecine expérimentale*, e.g. II, 1, § VIII (entitled "Dans les sciences biologiques comme dans les sciences physico-chimiques, le déterminisme est possible, parce que, dans les corps vivants comme dans les corps bruts, la matière ne peut avoir aucune spontanéité"), 136–137; Bernard, *Leçons sur les phénomènes de la vie communs aux animaux et aux végétaux*, 226.

[10] From the historical standpoint, we should follow Jean Gayon's cautionary remark that we should be careful when using, say, Bernard's judgments about 'vitalism' as historical pieces of evidence, since Barthez, Bernard and 'us' all have different conceptions of matter, living matter and the relations between them (Gayon, "Le vitalisme entre vie et mort," 99f.). That Bernard's conception of living matter, most strongly conveyed in his celebrated notion of *milieu intérieur* or 'internal environment', is itself strongly 'organizational' in the sense that it seeks to articulate a relation between inner and outer and between different organ systems (Noble, "Claude Bernard, the first systems biologist, and the future of physiology"), would be the basis for another paper.

[11] Vitalist scientific-theoretical practices (like other such practices) can also be appropriated by philosophers engaged in more specifically conceptual projects, whether this be Diderot's materialist usage of notions of sensibility (and the bee-swarm metaphor) or Hegel's idealist usage of Bichat's distinction in the *Recherches physiologiques sur la vie et la mort* between organic life and animal life, in order to emphasize the difference between subjectivity and the external world, in his philosophy of nature (on the latter, see Jacques d'Hondt, "Le concept de la vie chez Hegel").

Vitalism has suffered from its nineteenth-century reinterpretations in terms of 'vital forces' and 'entelechies', notably at the hands of Hans Driesch. It continues to be presented as a very extreme, almost mystical view in current biological and philosophical discourse: in a recent review of theoretical biology, we are told that "in vitalism, living matter is ontologically greater than the sum of its parts because of some life force ("entelechy," "*élan vital*," "*vis essentialis*," etc.) which is added to or infused into the chemical parts."[12] These authors are not denouncing vitalism in the name of genetic reductionism – indeed, they are seeking an anti-reductionist consensus in theoretical biology. However, 'vitalism' remains, in this context, the name for the unwelcome dinner guest.

Yet when we consider the body of writings produced by the 'Montpellier vitalists', that is, the physicians associated with the Faculty of Medicine at the University of Montpellier in the second half of the eighteenth century,[13] we find no traces of such metaphysically laden vital forces – or hardly any traces, for Paul-Joseph Barthez, the Dean of the School, flirts with the idea in the first edition of his *Nouveaux éléments de la science de l'homme* (1778; revised 1806) but gives up it subsequently. (Barthez had initially asserted the existence of an independent vital force, but withdrew this and added a chapter to the second edition of his book entitled "Skeptical considerations on the nature of the vital principle." He warned that one should follow an "invincible skepticism" (27; Notes, 98, n. 18) or a "reasonable Pyrrhonism" (226) when it comes to the vital principle. He only "personified" the vital principle, he explains, for ease of argument (107), for "one cannot have a priori knowledge of either Matter or Spirits" (83). In a wonderful phrase, he says: "I am as indifferent as could be regarding Ontology considered as the science of entities" (*Nouveaux éléments*, I, Notes, 96, n. 17). And Bordeu, in his work on the history of medicine, has a similar tone complaining about the murky vitalism of his teachers: "We used to ask, lastly, what this vital principle was that was responsible for night and day (*qui opère le blanc et le noir*), and governed that which was opposed to it. Fizes gave us various definitions, all of them obscure, which told us nothing…" (Bordeu, *Œuvres*, II, 972). Here, the tone of the pragmatic physician – even one interested in the theorization of living entities – is patent, in its skepticism towards the unnecessary invocation of metaphysically defined concepts of life. What does it mean to investigate the nature of life skeptically? Contrary to what one might expect, it does not mean to approach vital phenomena with a demystifying, deflationary attitude, but rather, that Barthez only wants to attribute properties to the vital principle "that result immediately from experience" (*ibid*.).

Hence we can interpret this 'Enlightenment' form of vitalism as *functional* rather than *substantive* (or *substantival*), as I have argued elsewhere: it is more of an attempt to 'model'

[12] Gilbert and Sarkar, "Embracing Complexity: Organicism for the 21st Century," 1.

[13] The significant figures of this school include Louis de La Caze (1703-1765), Jean-Joseph Ménuret de Chambaud (1739-1815; Ménuret was the – mainly unacknowledged – author of many important medical entries in the *Encyclopédie*, and published under the name Jean-Jacques and with the false date of birth 1733, for unknown reasons), Henri Fouquet (1727-1806), Théophile de Bordeu (1722-1776, also known due to his appearance as a fictional character in Diderot's *Rêve de D'Alembert*) and perhaps most famously, Paul-Joseph Barthez (1734-1806) in the later eighteenth century. Later figures of the School such as Jacques Lordat in the nineteenth century are of greater interest to a historian of scientific ideologies than to an *épistémologue* of the life sciences.

or ‘describe’ organic life without reducing it to fully mechanical models or processes, than an overt metaphysics of Life.[14]

In other words, Enlightenment vitalism is different from vitalism as understood (or feared) by the mainstream philosopher of biology or biologist, because it is more of an attempt to model the organizational, systemic properties of organisms than a positing of animas or immaterial life-forces, the latter implying a form either of overt substance dualism (e.g. soul vs. body, in which the soul is the life principle) or at least an argument that differentiates between living and non-living, or organic and inorganic systems, on the basis of a substantial difference. The distinction is clear in the (negative) remark of the prominent systems theorist Ludwig von Bertalanffy, according to which

> Organisms exhibit the properties of life not because of some special peculiarity of these compounds, but on account of the heterogeneous system into which these compounds are articulated. There is no “living substance” because the characteristic of life is the organization of substances.[15]

His “organizational” or relational definition of life would be a particular version of what I am calling ‘functional’ vitalism.

But perhaps we should not be too quick to dismiss the metaphysical commitments of vitalism and happily proclaim that it is one form of a kind of heuristic organicism (perhaps even a more ‘modern’, friendlier vision of embodiment free from some of the aporias of the ‘dialectic of Enlightenment’, as Elizabeth Williams suggests,[16] and I will return to this complex loser-winner-loser-winner dialectic below in section 4). In other words, maybe it is impossible to have a viable concept of vitalism without also having some degree of a metaphysical commitment towards either the uniqueness of living beings within the physical universe, whether this specificity be hypostatized into an ontological fact (this is the classic version, that of Georg-Ernest Stahl and, differently, of Hans Driesch’s ‘neo-vitalism’) or whether it is left as something accessible to naturalistic explanation, as we shall see. Thus in the next two sections I discuss the pertinence of the distinction between substantival and functional forms of vitalism as it can be contextualized in the seventeenth-eighteenth

[14] Benton (“Vitalism in nineteenth-century scientific thought”) discusses other similar distinctions between forms of vitalism, e.g. explanatory versus descriptive, or realist versus phenomenalist vitalisms. My interest in the notion of a ‘functional’ (structural, organizational) vitalism lies in the attention it pays to certain types of structures with functional properties. It is not just a matter of the (unresolvable?) question of whether such properties are real or not. In addition, my emphasis on ‘functional’ vitalism relates to my brief considerations as to how the latter might relate to the genesis of biology as a science. As regards terminology, I find post facto justification in the fact that e.g. Barthez, in his “Skeptical Considerations on the Nature of the Vital Principle” added to the 1806 edition of his *Nouveaux éléments de la science de l’homme*, speaks at length (part II, section XXXVI) of the problem of ‘substantializing’ the vital principle, or treating it as a substance rather than as, e.g., a Newtonian unknown.

[15] Von Bertalanffy, *Modern theories of development*, 48. That Bertalanffy doesn’t really develop what ‘organization’ means, as noted by Bohang Chen (discussion) lies beyond the scope of this paper.

[16] Williams presents vitalism as “markedly at odds with the universalizing discourse of Encyclopedist materialism, with its insistence on the uniformity of nature and the universality of physical laws” (*A Cultural History of Medical Vitalism in Enlightenment Montpellier*, 177).

centuries (with reverberations through the nineteenth-century constitution of physiology as a partly non-reductionist science).[17]

3. Substantival versus functional vitalism

We are familiar with vitalism as a strong, ontological commitment to the existence of certain entities or 'forces', over and above the system of causal relations studied and modeled by mechanistic science, which itself seeks to express these entities or the relations between them in mathematical terms. This is a common view of the subject, whether it is presented in positive terms, as a kind of commendable backlash against the de-humanizing, alienating trend inaugurated by the Scientific Revolution[18], which seeks to 're*vitalize* the world' or in negative terms, as a kind of anti-scientific or 'para-scientific' trend which needs to be refuted (as in the influential assertion by the famous molecular biologist Jacques Monod, in his essay on 'chance and necessity' in modern biology, *Le hasard et la nécessité*), that the persistence of teleological concepts in biology reflects ignorance, nothing more). And there is plenty of historical evidence that such a position existed.

But there is something wrong with this vision of things; not because we can adduce *one* counter-example but because the entire Montpellier *school* does not fit the description. And they are the ones for whom the term 'vitalist' was coined! After all, Barthez insisted in the "Discours préliminaire" added to the second edition of his work that he "never employed the term 'Principe Vital' to *explain* any vital phenomena," but rather to enable the stable formation of "new results" out of these phenomena (*Nouveaux éléments*, 1806 edition, I, Notes, 4), and he assured the reader of his "invincible skepticism" with regard to the Vital Principle (27).[19]

Following the fundamental work of Roselyne Rey, François Duchesneau and Elizabeth Williams, who have done much to put it on the map, I have argued elsewhere that the Montpellier vitalist school expresses a 'structural-functional' form of vitalism, with the

[17] On the constitution of physiology as a science from Claude Bernard to today, see Noble, "Claude Bernard, the first systems biologist, and the future of physiology."

[18] The reader familiar with older debates on the Scientific Revolution will recognize here the tone of Carolyn Merchant's *Death of Nature*, best described as follows (the specific example of Descartes can be generalized into the idea of 'modern science' overall): "A curious consensus in analytic history of philosophy, medical anthropology, feminist theory and cultural studies at large coalesces around the image of Descartes as anti-magus, stripping nature and the human body of all powers and activity. An earlier enchanted world, criss-crossed by networks of sympathies and antipathies, embracing analogy and suggestion over representation and intervention, traversed by holist herbalists and natural magicians, coupling early bodily realism with organicist ecologism, was sundered and lost with Descartes' blind scientistic drive for the mastery, possession and penetration of nature" (Sutton, *Philosophy and Memory Traces*, 82).

[19] However, as an anonymous reviewer of this article pointed out, it is also true that Barthez uses the term happily throughout the main body of his text, in this displaying a degree of conceptual nonchalance, not to say inconsistency which he shows elsewhere with regard to empiricism, induction, laws, the domain of medicine, etc. In that sense it would be unwise to claim that all Montpellier vitalists rejected substantial vital principles at all times. What is interesting about Barthez (and, it seems, unique in this regard) is his self-criticism precisely on this issue.

celebrated image of the *bee-swarm* (found in Maupertuis, Bordeu, Diderot[20] and also Ménuret de Chambaud's *Encyclopédie* article cited below) expressing the structural relation between one life and many lives. The structural-functional understanding of living systems, again, does not appeal to a special 'substance' to define them, but rather to what von Bertalanffy would have called an "organizational" understanding. In his fascinating and quite programmatic article in the *Encyclopédie* on the notion of 'animal economy', Ménuret defines the latter term as "*l'ordre, le méchanisme, l'ensemble* des fonctions & des mouvemens qui entretiennent la vie des animaux."[21] This is neither a strictly anatomical perspective on organisms, nor one appealing to an immaterial vital principle, including the soul. Rather, the vitalist interest here is on the *type of articulation of the parts* in an organism: both the specificity of the relation between the parts, and indeed the specificity of the material properties of these parts (i.e. the organs) themselves.

The animal economy in this context is very much a proto-organism concept (the term 'organism', although it had been used in the early 1700s in the debate between Leibniz and Stahl, does not appear in a stabilized form designating living organization before the late eighteenth century; authors such as Charles Bonnet or Immanuel Kant speak rather of 'organized bodies'[22]). Its fundamentally structural, functional, but also relational property appears in what was probably the most famous metaphor used to describe it, the bee-swarm. (And its status as metaphor, not as a literal designation of a particular type of entity, is important in Bordeu's discussion, where he is quite self-conscious about the need to approach the question of what makes a living system, living, through metaphors, as I emphasize below.) Here is Bordeu's version of the bee-swarm metaphor, in his masterpiece, the *Recherches anatomiques sur la position et la fonction des glandes* (1751), in a section entitled *How to understand the action of all the parts, their departments, and their periodic motions*:

> … there is a general circulation, and many particular circulations, which are, if I may speak thus, like small circles which gradually form a larger one.
>
> Hence the least part should be considered as 'a body apart', so to speak. True, it acts by means of the general circulation, but it is as distinct as the system of blood vessels is distinct from the chiliac vessel system, or as the circulation of the lung and the liver are from what occurs in ordinary large vessels.
>
> Might I make use of a comparison which, however rough, may be useful?
>
> I compare the living body, in order to properly assess the particular action of each part, to a swarm of bees which cluster together, and hang from a tree like a bunch of grapes; I find the image suggested by an ancient author, that one of the lower organs was an *animal in animali*, to be quite helpful. Each part is, so to speak, not quite an animal, but a kind of independent machine which contributes in its way to the general life of the body.
>
> Hence, following the comparison to a bee-swarm, it is a whole stuck to a tree branch, by means of the action of many bees which must act in concert to hold on; some others become

[20] See for some details Colas Duflo, "Diderot et Ménuret de Chambaud."
[21] Ménuret, "Œconomie Animale," 362a.
[22] See Tobias Cheung, "From the organism of a body to the body of an organism," and Charles T. Wolfe, "The organism as ontological go-between," and on the animal economy as an organism concept, Wolfe and Terada, "Animal Economy."

> attached to the initial ones, and so on; all concur in forming a fairly solid body, yet each one has a particular action, apart from the others; if one of them gives way or acts too vigorously, the entire mass will be disturbed: when they all conspire to stick close, to mutually embrace, in the order of required proportions, they will comprise a whole which shall endure until they disturb one another.[23]

The language of 'concurrence', interaction, cohesion or consensus of the parts is also attributed in this text to the Hippocratic tradition (with intimations of the Hippocratic image of the 'circle' of life). And Ménuret goes on to explain how a stable interaction between parts ("lives," i.e. individual organs) is what constitutes health. In his article on "Observation" in the *Encyclopédie*, Ménuret mentions the bee-swarm and Bordeu in order to emphasize that life in the body occurs, or is best described as, a "connection of actions" ("liaison d'actions"):

> One could, following these authors, compare man to a flock of cranes which fly together, in a particular order, without mutually assisting or depending on one another. The Physicians or Philosophers who have studied and carefully observed man, have noticed this sympathy in all animal movements – this constant and necessary agreement in the interaction of the various parts, however disparate or distant from one another; they have also noticed the disturbance of the whole that results from the sensory disagreement of a single part. A famous physician (M. de Bordeu) and an illustrious physicist (M. de Maupertuis) likewise compared man, from this luminous and philosophical point of view, to a swarm of bees which strive together to hang to a tree branch. One can see them pressing and sustaining one another, forming a kind of whole (*une espèce de tout*), in which each living part contributes in its way, by the correspondence and direction of its movements, to sustain this kind of life of the whole body, if we may refer in this way to a mere connection of actions (*liaison d'actions*).[24]

What the 'vitalist' Ménuret is doing here with the bee-swarm metaphor for the animal economy (or 'organism' in our vocabulary, as I have argued elsewhere, pointing to the numerous cases in which the animal economy, when it is taken as an object of study, not as a field of research, is presented as a more sophisticated type of arrangement of and relation between the parts than mere mechanisms) is asserting a structural, relational, positional approach to what makes living bodies unique.

Many commentaries on the image of the bee-swarm relate it to its more popular usage as a metaphor for social, economic or political order in works such as Mandeville's *Fable of the Bees*.[25] But there is no innate socio-political 'moral' to be derived from the vitalist usage of the bee-swarm metaphor for organismic unity. Granted, nineteenth-century 'biologizations of the social' and their early twentieth-century fascistic outcomes tended to privilege a purportedly natural and authentic ('holistic') metastability over and against individual desires, appetites and values. But the vitalist emphasis here is that the individual bees (organs) in the bee-swarm (organism) should be understood as individual *lives*, rather than as passive

[23] Bordeu, *Recherches anatomiques*, § CXXV, in Bordeu, *Œuvres*, vol. 1, 187.
[24] Ménuret, "Observation," 318b-319a.
[25] For some comparative study of biological and social usages of the bee-swarm metaphor see Schlanger, *Métaphores de l'organisme* and Sheehan and Wahrman, *Invisible Hands*.

components of a mechanism. And the metaphor of the machine has its own dubious socio-political posterity.

Suffice it to say that such derivations from the Enlightenment texts are neither obvious nor very enriching as regards the understanding of the concepts at work here (nineteenth-century reinterpretations of these ideas within the Montpellier School, such as Jacques Lordat's, did in contrast seek to turn them into hardened monarchist positions…[26]). Bordeu, Ménuret or Fouquet would have been bewildered by an anti-'organismic' assertion such as this: "We are not organisms, but persons. The nexus of relations which unites us in a human society is not organic but personal."[27] One can also overplay the revolutionary dimension of the bee-swarm metaphor, as in Peter Hanns Reill's judgment that "Enlightenment vitalism was not politically conservative, though some of its proponents may have been. Rather, it employed the images of consent and cooperation; it spoke of the assembly of forces and their free play; its image of organization excluded a single directing power or 'royal' force. As such it often contained liberal and sometimes revolutionary overtones."[28]

So I return to my primary interest: what model of order, what model of organization does the vitalist discussion of the animal economy, metaphorized as the bee-swarm, yield? In fact, it is not univocal.

For instance, one should note the presence of (partly) mechanistic language in Ménuret's descriptions (more than in Bordeu's for instance), with the language of 'springs' (*ressorts*). This implies that even if we are faced with a form of holism here (as the idea of a 'Life' composed of smaller 'lives' makes explicit), it is a holism where componential analysis, that is, analysis of the properties of the parts, still plays a role. In that sense, not only is the form of vitalism expressed in the above passages far removed from claims about mysterious vital forces; this structural-functional approach to life is also closer to materialism than is often said, if we notice the appeal to a kind of *vital materiality*. As Diderot put it, playing on the most classic mechanist analogy: "What a difference there is, between a sensing, living watch and a golden, iron, silver or copper watch!"[29] The difference is of course one of the particular material realization of 'watch', that is, a flesh-and-blood arrangement of parts versus a strictly mechanical arrangement of parts – and also a difference in organization, since Diderot emphasizes that the organic continuity of the flesh has systemic differences with the strictly spatial 'continuity' of non-living matter due to the presence of the nervous system in the former.

If the model of organic organization (or "animal economy") on display here, conveyed through the image of the bee-swarm, is an organism concept, it should be stressed that it is a structural and relational concept of organism rather than a more 'Romantic' concept which opposes living organization to that of a machine or matter in general in terms of a 'centre', an 'inside', a

[26] See Lavabre-Bertrand, *La philosophie médicale de l'école de Montpellier*.

[27] John Macmurray, *Persons in Relation*, 46.

[28] Reill, *Vitalizing Nature in the Enlightenment*, 12.

[29] Diderot, *Éléments de physiologie*, in Diderot, *Œuvres complètes*, XVII, 335. On the interplay between vitalism and materialism in the Montpellier context see Wolfe and Terada, "The Animal Economy," and, particularly on Diderot, Kaitaro, *Diderot's Holism*.

kind of self. As Denise Leduc-Fayette put it, "from organization to organism, there is only one step to be taken, which Romantic philosophy will take."[30] These two models of organization are, indeed, two forms of vitalism, one substantival (and ultimately "Romantic," as it were) and one functional, appealing to particular structural arrangements. The functional vitalist could declare, like von Bertalanffy cited above, that "Organisms exhibit the properties of life not because of some special peculiarity of these compounds, but on account of the heterogeneous system into which these compounds are articulated. There is no "living substance" because the characteristic of life is the organization of substances" (*Modern theories of development*, 48).

One might object that there is a tension between the structural, relational emphasis on the bee-swarm as a particular type of *arrangement or organization*, and the materialist emphasis – whether vital or not – on a particular type of *matter*. But in fact, both conceptual figures seep into one another, and both oscillate or waver in terms of one another: sometimes Diderot will seek to define the properties of this "sensing, living" matter in organizational terms, and similarly, sometimes the animal economy is presented in more or less materialist terms, including when Bordeu, Fouquet and Ménuret reproach Stahl for not providing a sufficient material account of the processes he attributes to the *anima*. In addition, it is perhaps not a negligible terminological fact that when the Montpellier authors first spoke of 'vitalism' and 'vitalists', they observed that the term was synonymous with 'sensibilist'. Thus, when reflecting on the vitalist movement in the first years of the nineteenth century, the physician Henri Fouquet simply stated that the terms amount to the same thing – "the doctrine of sensibility is the same as that of *vitalism*" – since "whatever is sensitive is vital."[31] Sensibility or sensitivity was of course a key feature of organic life, experimentally defined by Albrecht von Haller in his celebrated experiments, that materialists such as Diderot transposed into a property of living matter itself. Vital materiality also implies a concern with individuality, with the individual as a specific organizational cluster: as Diderot writes, "this swarm is an entity, an individual."[32]

Contrasting with the rather blunt, ahistorical warnings of a Monod, but also with the more nuanced concerns of Gilbert and Sarkar (for whom, recall, 'vitalism' meant an appeal to vital forces, principles or entelechies, while 'organicism' was a non-metaphysically based project to understand the specificities of vital organization, akin to what I have called structural-functional, or relational vitalism), we have seen that Montpellier vitalism in its predominant varieties was more of

[30] Denise Leduc-Fayette, "La Mettrie et Descartes," 45. In his *Vitalizing Nature in the Enlightenment* Peter Hans Reill also opposes vitalism to, in his case, *Naturphilosophie*, on similar grounds; see the useful discussion in Gaukroger, "'The Enlightenment Revolt Against Rationalism': Critical Notice of Peter Hanns Reill, *Vitalizing Nature in the Enlightenment*," and Zammito, "From Vital Materialism to Naturphilosophie." In this respect I follow Reill's opposition between a more metaphysical position (*Naturphilosophie*) and a more heuristically oriented inquiry into life (vitalism); this maps onto my distinction between substantival and functional vitalism. However, scholars of Romanticism will object that it was quite empirically oriented (see e.g. R. Mitchell's *Experimental Life*). In earlier work on the topic I opposed the Montpellier vitalist notion of organization to other concepts of organism in terms of materialism-friendly perspectives versus ones which appealed to a foundational interiority; here I am simply suggesting that we should distinguish between two approaches to structure and organization, in which the Montpellier vitalist approach, which I've described as structural and relational (one could also say "organizational", at the risk of sounding tautologous) is less hostile to mechanism and to the power of reductionist explanations of components, than we might think.

[31] Fouquet, *Discours sur la clinique*, 78.

[32] Diderot, *Rêve de D'Alembert*, in Diderot, *Œuvres complètes*, XVII, 120.

an organizationally motivated explanatory project, and also materialism-friendly (particularly in Ménuret and Fouquet, and in Bordeu to a lesser degree). But if the Montpellier vitalists were not 'cranks' or freaks, who *did* believe in an immaterialist, supernaturalist form of vitalism? That is, ontological rather than explanatory teleology; immaterial forces playing a causal role in a material world; a metaphysically grounded concept of Life? A prime candidate would be Georg-Ernest Stahl, a court physician to Duke Johann Ernst of Saxon-Weimar and subsequently, as of 1694, a Professor of Medicine at the University of Halle and author of various works on chemistry, medicine and the difference between mechanism and organism. Stahl describes the body and its organs as literally mere instruments of the soul; even when he seems to step back from this position in its literal form, reflecting that "organs are not, as the name might suggest, mere instruments," he adds that nevertheless, "it is the soul that makes the lungs breathe, the heart beat, the blood circulate, the stomach digest, the liver secrete"[33]: this is a strong teleology. And throughout the collection of essays entitled *Theoria medica vera*, he asks about 'what we call Life', 'what purpose does it serve', within and outside the body? Indeed, in his teleology, his animism and his insistence on an ontology of Life which would be more foundational than specific enquiries such as in chemistry or medicine, Stahl seems the canonical version of a substantival vitalist.

4. Losers and winners? Stahl, Driesch and the Montpellier critique

There was indeed a more animism-friendly side of the spectrum of Montpellier vitalism, represented by François Boissier de Sauvages, who added a Stahlian component, the soul as central explanatory principle in organic processes of self-maintenance[34], although he also defended the pertinence of mechanical and mathematical explanations in medicine (referring notably to Newton). Yet the Montpellier vitalists predominantly reject the 'substantival vitalism' in Stahlian animism; its ontology, indeed the very fact that it *has an ontological component*. Granted, they are also anti-mechanistic, as can be seen e.g. in Bordeu's reflections on the history of medicine: "Spare us, once and for all, all these tiny fibres, pressures, globules, thick substances, sharp angles, lymph, hammers and all the rest of the equipment from mechanical workshops with which [earlier doctors] filled the living body – they were the playthings of our fathers" (Bordeu, *Œuvres*, II, 670). But despite their criticism of mechanistic models for Life – for their inertness, for their inapplicability to living beings, and so forth – the Montpellier vitalists are quite dismissive of this Stahlian intrusion of a non-medical entity (the soul) into medical explanations. Here is Ménuret:

> Who wouldn't laugh at an animist or Stahlian who would argue that this illness is a gift of Nature or the soul, a kind and farsighted mother who directs all efforts to heal the illness, and even exacerbates them on the pretext of necessity, hoping for benefits that one hopelessly expects from elsewhere? ("Ténesme," *Enc*. XVI, 137a).

[33] Stahl, *Disquisitio de mecanismi et organismi diversitate*, § XCVIII, in Stahl, *Œuvres médico-philosophiques et pratiques*, 347; Hall, *Ideas of Life and Matter*, vol. 1, 363. For a less metaphysical, more science-friendly perspective on Stahl, see the work of Kevin Chang, e.g., "Fermentation, Phlogiston and Matter Theory: Chemistry and Natural Philosophy in Georg Ernst Stahl's *Zymotechnia Fundamentalis*."

[34] Sauvages, *Dissertation sur les médicaments*, in *Les Chefs-d'œuvre de Monsieur de Sauvages*, II, 26-27; Sauvages, *Nosologie méthodique*, I ("Prolégomènes"), 4, 10, 45.

But on the other hand the status of chemistry is not univocal. Stahl deserves credit for insisting on the unique chemical composition of life (or, put more philosophically, the fact that claims for the ontological specificity of life can be bolstered by chemical analyses). He emphasizes the importance of chemistry for conceptualizing what is unique in organic beings (their characteristic *mixtio* rather than mere aggregates) but, somewhat dialectically, he adds that once that reaches the level of a *theoria medica vera*, then one can dispense with the chemical analysis of bodies, like the ladder we leave behind after having climbed up it (not his image!), e.g. in the 1706 *Paraenesis ad aliena a medica doctrina arcendum*.

This link between Stahlian chemistry and vitalism is patent in the figure of Gabriel-François Venel, the French Stahlian chemist who was close to the doctors of the Montpellier medical school, and also authored the important article "Chymie" in the *Encyclopédie*.[35] Here, chemistry has as its main goal to understand the specificity of life. François Pépin suggests that "chemistry and vitalism" worked together "in an open, mutually beneficial and non-hierarchical relationship."[36] Yet what are the respective ontological commitments of vitalism *and* chemistry? If one contrasts figures such as Stahl (on the one hand) and Venel (on the other hand), with Bordeu somewhere in between, a whole gradation of views emerges on whether chemistry helps justify the specificity of living beings, or whether a science of living beings has to defend itself against the (reductionist?) encroachment of chemistry. Venel seems to hold the former view, Stahl the latter, and Bordeu worries about both extremes. But Bordeu's way of occupying an ontological middle ground is also related to his practice of *metaphor*, which I have mentioned above, but shall seek to clarify now.

In his *Recherches anatomiques sur la position et la fonction des glandes*, when discussing the problem of whether the secretory process of the glands can be reduced to a type of *sensation* or not, Bordeu critiques Stahl's notion of anima but without making a frontal empirical disagreement (thus unlike Ménuret as quoted above). Bordeu emphasizes that both this idea of sensation and Stahl's anima are *metaphors*:

> This is again one of these *metaphors* which must be allowed us ; . . . It is difficult . . . to explain oneself, when it comes to speaking of the force which so carefully directs a thousand singular motions in the human body and its parts; what terms should we use to describe them? . . . We will discuss Stahl's hypothesis elsewhere: he claimed that the soul directed everything in the animal body. Whatever the case may be, we can state that all living parts are directed by an ever-vigilant *force conservatrice*; does this force belong, in certain respects, to the essence of a part of matter, or is it a necessary attribute of its combinations? . . . We can only suggest a *way* of conceiving things, *metaphorical* expressions, comparisons...[37]

[35] See Pépin, *La Philosophie expérimentale de Diderot* and the essays by Lehman and Pépin in Nouvel, ed., *Repenser le vitalisme* – Lehman speaks of a "chemical vitalism" (130).

[36] Pépin, "Vitalisme, chimie et philosophie autour de l'*Encyclopédie* et de Diderot," in Nouvel, ed., *Repenser le vitalisme*, 133. Chemistry and vitalism are also presented as interrelated and mutually influencing one another in the Scottish Enlightenment context, in Tamás Demeter, "A Chemistry of Human Nature: Chemical Imagery in Hume's Treatise," in this volume.

[37] Bordeu, *Recherches anatomiques*, § CVIII, in Bordeu, *Œuvres*, vol. 1, 163.

To say that the Stahlian concept of soul is a metaphor (which Stahl does not say!) is essentially to say that the concept has *functional* value (or not) depending on how well it models phenomena – rather than making a claim about what sorts of things exist. The vitalists neither countenance the irrationalism – or better, supernaturalism – of Stahl's anima, nor, of course, are they mechanists. *Yet* their vision of 'animal economy ' – of organism – is predominantly a *structural-functional* one, in contrast to Stahl's more substantival vitalism.

The Stahlian belief in 'anima' is quite similar *qua* form of vitalism, to the position of the embryologist Hans Driesch in the late nineteenth century. Driesch comes out of the school of Wilhelm Roux's *Entwicklungsmechanik* or study of the mechanisms of the developmental process, and (in)famously moved from experimentation with sea urchin eggs, discovering feature of "totipotency," to the metaphysical theory of *entelechies* existing in all living organisms. Faced with the evidence that there was no physical structure we can find in the sea urchin embryo which is responsible for the "regulative" or "equipotential" force, he felt obliged to posit a non-spatial vital force, the entelechy.

A careful consideration of authors such as Bordeu, Fouquet, Ménuret and Barthez (at least starting with the second edition of his *Nouveaux éléments*, where he makes some effort to eliminate the language of 'vital force' and 'vital principle', or at least express skepticism towards such entities as 'personified') would show that it is possible to have a non-reductionist approach to biological organization, including in some cases a kind of 'expanded mechanist' approach, without it amounting to a substantival vitalism of either the Stahlian or the Drieschian sort. That is, in the (perhaps deliberately provocative) terms of Georges Canguilhem, "Eighteenth-century vitalists are . . . not impenitent metaphysicians but rather prudent positivists, which is to say, in that period, Newtonians."[38] Of course, this raises more questions than it answers. For instance, which entities are legitimate bases for vitalism? The Montpellier vitalists, given their medical focus, are primarily anthropocentric but could extend their analysis to animals; Driesch builds a kind of metaphysics of the sea urchin; Stahl's animism is also a 'chimio-vitalism', a doctrine of vital chemistry.

5. Conclusion

Vitalism 'rotates' here through more substantival (foundational and at times dualist) and more functional (organizational, animal-economic) forms. Only in the first form is it a doctrine in which "living matter is ontologically greater than the sum of its parts because of some life force ("entelechy," "*élan vital*," "*vis essentialis*," etc.) which is added to or infused into the chemical parts" (to reiterate Gilbert and Sarkar's definition), although it should be acknowledged that to presume the existence of something is not directly tantamount to a metaphysical position: precisely, vital force talk in Blumenbach or Bordeu is deliberately 'ontologically empty'. As a particular case of the second form, I discussed a reconstructed version of the doctrine of the Montpellier School.

[38] Canguilhem, *Réflexe*, 113; he adds rather provocatively that "Vitalism is first of all the rejection of all metaphysical theories of the essence of life" (ibid.). For more discussion of the role of Newtonian analogies in eighteenth-century biology (from very literal to very analogical usage) see Wolfe, **"**On the Role of Newtonian Analogies in Eighteenth-Century Life Science" and for a provocative and rich treatment of the 'Newtonian analogy' problem in moral philosophy, specifically, which, somehow dovetailing with the present essay, insists on its organic roots, see Tamás Demeter, "A Chemistry of Human Nature: Chemical Imagery in Hume's Treatise," in this volume.

Here, no metaphysical postulates of immaterial entities or forces, like Driesch's entelechies, are found. It is a more practical, heuristically oriented medical and philosophical program that uses functional, Newtonian-inspired models of organism to discuss temporal, dynamic and sometimes subjective dimensions of embodiment – disease, crisis, pulse, nosology … In addition to these two forms of vitalism – *substantival* (Stahl, Driesch) and *functional* (the Montpellier School), which articulate different models of living organization (as regards issues such as unity, structure, and interrelation) in the twentieth century, thinkers such as Kurt Goldstein and Georges Canguilhem developed a more *existentially* defined vitalism, understood as an *attitude* living beings necessarily adopt towards other such beings.[39] Eighteenth-century discussions of biological organization do not, in contrast, seem especially concerned with the question of the 'observer', although Kantians might wish to differ. Vitalism thus comes in different forms, some of which seem well beyond the pale for mainstream biological thought, while others can serve as useful heuristics or correctives in attempting to deal with the question of the ontological status of living entities. As regards its posterity in the life sciences, I shall make two final remarks.

First, as regards the status of vitalism in the history of science. The perpetually reinvented polemical dimension of vitalism – in which a thinker seeking to articulate a claim for the autonomy of biological entities can accuse his predecessor of having been the *real* vitalist, whereas the 'legitimate' life scientist is simply an experimentalist – seems to belong to the problems of the conceptualization of the biomedical fields as a whole. (That the words 'vitalism' and 'biology' are coined at about the same time, as I mentioned earlier, is the sign of something worth investigating.) In the present case, this includes the very broad question 'does vitalism impact the history of science?' and the slightly more specific 'does vitalism lead to a science such as biology?' In either of these two cases, we are faced with the possible 'legitimization' or 'normalization' of what was thought to be a marginal or scientifically superfluous movement, by seeking to inscribe it in a narrative of the development of biological science. The possibility of such an inscription allows of both a stronger and a weaker interpretation. The stronger case for vitalism is the sort made by partisans of, e.g. theoretical biology whose anti-reductionism is very zealous – a kind of non-negotiable commitment.[40] The weaker case is easier to defend, because it is less directly falsifiable. It includes the more functional form of vitalism, which is also harder to present in 'refutable' terms. In a sense, the mirror image of the stronger case for vitalism is the classic reductionist position, for which vitalism *sensu* Stahl or Driesch is to be consigned to the rubbish heap of history (that is, science). On the one hand, for the historical epistemologist these are all different constellations to be studied without normative bias. On the other hand, for the more conceptual approach I have sketched out here, not all approaches are equal, but I leave that open to discussion.

[39] See Goldstein, *Der Aufbau des Organismus*, and Canguilhem, "Aspects du vitalisme," which presents vitalism as a kind of *attitude*, rather than one historical episode amongst others: "Vitalism expresses a permanent requirement or demand [*exigence*] of life in living beings, the self-identity of life which is immanent in living beings. This explains why mechanistic biologists and rationalist philosophers criticize vitalism for being nebulous and vague. It is normal, if vitalism is primarily a 'demand', that it is difficult to formulate it in a series of determinations" ("Aspects du vitalisme," 86). On Goldstein's theory of organism see Ferrario and Corsi, "Vitalism and Teleology in Kurt Goldstein's Organismic Approach."

[40] See my discussion of contemporary forms of biological holism in "Holism, organicism and the risk of biochauvinism."

Further, the mainstream reductionist position according to which the science of life needs to dispense with foundational or otherwise essentialist inquiries into the nature of Life itself (not to mention biological projects motivated by a metaphysics of Life) can also take the form of the more Stoic 'constat' of a great biologist like François Jacob, that we no longer 'inquire into Life'[41], i.e., that the concept of Life, and by extension any ontologically foundational clauses attached to work in the life sciences, no longer serves any purpose in such work. Now, the historical epistemologist could take inspiration from Jacob's verdict on modern biology and suggest that the crystallization of biology as a discipline, both in terms of terminological stabilization and of 'practice' understood as contributing to an organized discipline, may not have required a strong concept of Life (including in the sense of an ontology of Life), *even though* vitalist ideas may have played more of a role in such a crystallization than is often thought.[42] Perhaps disappointingly to the strong vitalist, and frustratingly to the 'deflationist', in none of the cases discussed here, including Stahl and the Montpellier vitalists, does it appear to be straightforwardly the case that a vitalist 'theory' or 'claim' or 'metaphor' gets naturalized or formalized or quantified and turned into mainstream science – with the exceptions of Blumenbach et al. (in embryology rather than medicine). However, there is a distinctive 'form of life' that emerges in the reflections of the Montpellier School and the various related projects, whether antecedent (Glisson, Stahl), contemporary and congenial (Diderot), contemporary and competitive (Haller), or posterior (Cabanis, Bichat, Bernard).

My second concluding remark concerns the nature of vital organization as understood in the vitalist corpus I have discussed. Notably, the understanding of organic individuality in the vitalist authors surveyed above does not treat such individuality (a.k.a. specific modes of organization) as a thing but as a 'system', a dynamic relation between individual vital centres (the little 'lives') which are interrelated by means of 'sympathy', 'consensus', 'conspiration' etc., that is, various forms of reciprocity, in a "circle of action."[43] ('Sympathy' is used here in a strictly naturalistic sense, befitting its later usage as in the 'sympathetic nervous system.) What Bordeu's insistence on the metaphorical character of the bee-swarm also tells us is that such a system has no a priori existence, as it is the outcome of particular interactions. But this relational character of the bee-swarm means it is not just an empty metaphor, although it is also not restrictive: the model of organic organization as something constituted by the relations between these little "lives," like in a bee-swarm, can nevertheless be interpreted structurally in different senses, depending on the extent to which 'structure' is ontologized:

> — as a kind of "structure of structures," in which each part of a living being is a structure, or better, each arrangement of these parts is a structure. But this runs of the risk of collapsing organic organization back into mechanism, since it is primarily if not exclusively a *spatial*

[41] "On n'interroge plus la vie aujourd'hui dans les laboratoires" (Jacob, *La logique du vivant*, 320).

[42] On the historical question regarding the conceptual conditions of the emergence of biology as a science in the late eighteenth century, see the forthcoming volume *Philosophy of Biology Before Biology*, eds. C. Bognon-Küss and C.T. Wolfe.

[43] In that sense, I do not see why the vitalist notion of organization as the "material result of a composition" should be opposed to that of the "equilibrium of a dynamic system," as is argued by Dominique Guillo, *Les figures de l'organisation*, 44. Contrast the sensitive reading of Enlightenment biophilosophy by Tobias Cheung, who stresses the emergence of a structural, relation, systemic conception of organism, which is quite consonant with my 'functional vitalism': e.g. Cheung, "Charles Bonnets allgemeine Systemtheorie organismischer Ordnung."

understanding; conversely, this structural presentation can also reduce the organism to a kind of pure mind or self, including in the weaker form of an inner teleology, an inner sense which governs the destiny of the body, which the Montpellier vitalists never do (the situation is different in so-called 'neo-vitalism' a century later).

— Conversely, the type of organic unity that we can see being intimated, sketched out and sometimes metaphorized in the Montpellier texts, can be understood as structural and relational, as I have discussed above. An added feature here would be that, since this organization is necessarily the product of interaction between material components, it is "emergent." That, despite some of the criticisms of early modern mechanism we encountered in these authors (e.g. Bordeu), this picture of organization seems mechanist-friendly should not be so surprising, given that the animal economy here cannot be conceptualized otherwise than as an analysis of the components of the body (even if, to be sure, the interaction between these components, e.g. in the case of glandular secretions, leads to the modelling of functional properties far different from anything on display in Descartes, Borelli or Boerhaave). In Ménuret's words:

> everything leads us to believe that the human body is like the other machines which art can assemble, disassemble, and witness in their tiniest springs; it is a fact known to any artist, that in even the most complex machines, the entire movement rests and bears on one particular piece from which the movement began, and from which it spreads to the rest of the machine, producing various particular effects in each particular spring. It is only by discovering such a spring in man that we can come to properly know and determine the manner of acting of the general causes of life, health, sickness and death.[44]

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References

Paul-Joseph Barthez, *Nouveaux éléments de la science de l'homme*, 2nd edition (Paris, 1806).
Paul-Joseph Barthez, *Nouveaux éléments de la science de l'homme*, 3d revised edition, 2 vols. (Paris, 1858).
E. Benton, "Vitalism in nineteenth-century scientific thought: a typology and reassessment." *Studies in History and Philosophy of Science Part A*, 5/1 (1974), 17-48.
Claude Bernard, *Introduction à l'étude de la médecine expérimentale* (Paris, 1865).
Claude Bernard, *Leçons sur les phénomènes de la vie communs aux animaux et aux végétaux*, vol. 1, ed. A. Dastre (Paris, 1878).
Ludwig von Bertalanffy, *Modern theories of development*, trans. J.H. Woodger (London, 1933).
Xavier Bichat, *Recherches physiologiques sur la vie et la mort* (Paris, 1800).
Johann Friedrich Blumenbach, *Über den Bildungstrieb* (Göttingen, 1791).

[44] Ménuret, "Œconomie Animale," 362b.

Cécilia Bognon-Küss and Charles T. Wolfe, eds., *Philosophy of Biology Before Biology* (London, forthcoming).
Théophile de Bordeu, *Recherches anatomiques sur la position des glandes et leur action* (Paris, 1751).
Théophile de Bordeu, *Œuvres complètes*, précédées d'une Notice sur sa vie et ses ouvrages par Monsieur le Chevalier de Richerand, 2 vols. (Paris, 1818).
Georges Canguilhem, *La formation du concept de réflexe aux XVII^e^ et XVIII^e^ siècles* (1955), 2nd revised edition (Paris, 1977).
Georges Canguilhem, "Aspects du vitalisme," in Canguilhem, *La connaissance de la vie*, revised edition (Paris, 1965).
Kevin M. Chang, "Fermentation, Phlogiston and Matter Theory: Chemistry and Natural Philosophy in Georg Ernst Stahl's *Zymotechnia Fundamentalis*," *Early Science and Medicine*, 7 (2002), 31-64.
Tobias Cheung, Charles Bonnets allgemeine Systemtheorie organismischer Ordnung. *History and Philosophy of the Life Sciences, 26* (2005), 177-207.
Tobias Cheung, "From the organism of a body to the body of an organism: occurrence and meaning of the word 'organism' from the seventeenth to the nineteenth centuries," *British Journal for the History of Science*, 39/*3* (2006), 319-339.
Guido Cimino, François Duchesneau, eds., *Vitalisms: from Haller to the cell theory* (Firenze, 1997).
Tamás Demeter, "A Chemistry of Human Nature: Chemical Imagery in Hume's Treatise," *Early Science and Medicine* (**this issue**).
Denis Diderot, *Œuvres complètes*, eds. Herbert Dieckmann, Jacques Proust, Jean Varloot (Paris, 1975-).
Denis Diderot & Jean le Rond D'Alembert, eds., *Encyclopédie ou Dictionnaire raisonné des sciences, des arts et des métiers…*, 35 vols. (Paris, 1751-1765).
Hans Driesch, *Der Vitalismus als Geschichte und als Lehre* (Leipzig, 1905; reprinted Bremen, 2012).
François Duchesneau, "Blumenbach on Teleology and the Laws of Vital Organization," *Verifiche*, 48/1-3 (2014), 115-138.
Colas Duflo, "Diderot et Ménuret de Chambaud," *Recherches sur Diderot et sur l'Encyclopédie,* 34 (2003), 25-44
Chiara Elettra Ferrario & Luigi Corsi, "Vitalism and Teleology in Kurt Goldstein's Organismic Approach," in S. Normandin and C.T. Wolfe, eds, *Vitalism and the Scientific Image, 1800-2010* (Dordrecht, 2013), 205-241.
Henri Fouquet, *Discours sur la clinique* (Montpellier, 1803 [an XI]).
Andrea Gambarotto, *Vital Forces, Teleology and Organization. Philosophy of Nature and Biology in Germany (1752-1802)* (Dordrecht, forthcoming)
Stephen Gaukroger, "'The Enlightenment Revolt Against Rationalism': Critical Notice of Peter Hanns Reill, *Vitalizing Nature in the Enlightenment*," *Australian Review of Public Affairs* 26 (2005). http://www.australianreview.net/digest/2005/11/gaukroger.html.
Jean Gayon, "Le vitalisme entre vie et mort dans la pensée des lumières," In *Philosopher sans frontières : hommage à Joachim Kopper* (Dijon, 1994), 99-119.

Scott Gilbert & Sahotra Sarkar, "Embracing Complexity: Organicism for the 21st Century," *Developmental Dynamics*, 219 (2000), 1-9.
Kurt Goldstein, *Der Aufbau des Organismus. Einführung in die Biologie unter besonderer Berücksichtigung der Erfahrungen am kranken Menschen* (Den Haag, 1934).
Dominique Guillo, *Les figures de l'organisation. Sciences de la vie et sciences sociales au 19e siècle* (Paris, 2003).
Thomas S. Hall, "On biological analogs of Newtonian paradigms," *Philosophy of Science* 35/1 (1968), 6-27
Thomas S. Hall, *Ideas of Life and Matter. Studies in the History of General Physiology*, 2 vols. (Chicago, 1969).
Jacques d'Hondt, "Le concept de la vie chez Hegel," in *Hegels Philosophie der Natur*, eds. Rolf-Peter Horstmann & Michael J. Petry (Stuttgart, 1986), 138-150..
François Jacob, *La logique du vivant* (Paris, 1970).
Timo Kaitaro, *Diderot's Holism. Philosophical Anti-Reductionism and its Medical Background* (Frankfurt, 1997).
Thierry Lavabre-Bertrand, *La philosophie médicale de l'école de Montpellier au XIXe siècle*. Thèse de doctorat, Paris, École Pratique des Hautes Études, IVe Section (1992).
Denise Leduc-Fayette, "La Mettrie et Descartes," *Europe*, special issue on Descartes (1978), 37-48.
John Macmurray, *Persons in Relation*, Gifford Lectures (New York, 1961)
Jean-Joseph Ménuret de Chambaud, "Œconomie Animale (Médecine)," *Encyclopédie ou Dictionnaire raisonné des sciences, des arts et des métiers*, XI (Paris, 1765), 360-366.
Jean-Joseph Ménuret de Chambaud, "Observation (Gram. Physiq. Méd.)," *Encyclopédie ou Dictionnaire raisonné des sciences, des arts et des métiers*, XI (Paris, 1765), 313-321.
Carolyn Merchant, *The Death of Nature: Women, Ecology, and the Scientific Revolution* (New York, 1980).
R. Mitchell, *Experimental Life: Vitalism in Romantic Science and Literature* (Baltimore, 2013).
Jacques Monod, *Le hasard et la nécessité. Essai sur la philosophie naturelle de la biologie moderne* (Paris, 1970).
Denis Noble, "Claude Bernard, the first systems biologist, and the future of physiology," *Exp. Physiol.*, 93/1 (2008), 16–26.
Pascal Nouvel, ed., *Repenser le vitalisme* (Paris, 2011).
François Pépin, *La Philosophie expérimentale de Diderot et la chimie* (Paris, 2012).
Peter Hanns Reill, *Vitalizing Nature in the Enlightenment* (Berkeley, 2005).
Roselyne Rey, *Naissance et développement du vitalisme en France de la deuxième moitié du 18e siècle à la fin du Premier Empire* (Oxford, 2000)
François Boissier de Sauvages, *Les Chefs-d'œuvre de Monsieur de Sauvages, ou Recueil de dissertations qui ont remporté le prix dans différentes Académies…*, 2 vols. (Lausanne and Lyon, 1770)
François Boissier de Sauvages, *Nosologie méthodique, dans laquelle les maladies sont rangées par classes, suivant le systême de Sydenham, & l'ordre des Botanistes* [1763], trans. Nicolas, 3 vols. (Paris, 1771).
Moritz Schlick, "Naturphilosophie," in Max Dessoir, ed., *Lehrbuch der Philosophie*, vol. 2: *Die Philosophie in ihren Einzelgebieten (*Berlin, 1925), 393-492

Moritz Schlick, "Philosophy of organic life," in H. Feigl & M. Brodbeck, eds., *Readings in the Philosophy of Science* (New York, 1953), 523-536. (Excerpt from Schlick, "Naturphilosophie.")
Jonathan Sheehan, Dror Wahrman, *Invisible Hands. Self-Organization and the Eighteenth Century* (Chicago, 2015).
Georg Ernst Stahl, *Disquisitio de mecanismi et organismi diversitate* [1706], in *Œuvres médico-philosophiques et pratiques*, trans. Théodore Blondin, ed. Louis Boyer, vol. 2. (Paris, 1859).
John Sutton, *Philosophy and Memory Traces. Descartes to connectionism* (Cambridge, 1998).
Elizabeth A. Williams, *A Cultural History of Medical Vitalism in Enlightenment Montpellier* (Burlington, 2003).
Charles T. Wolfe, "Holism, organicism and the risk of biochauvinism," *Verifiche*, 48/1-3 (2014), 41-60.
Charles T. Wolfe, "On the Role of Newtonian Analogies in Eighteenth-Century Life Science: Vitalism and Provisionally Inexplicable Explicative Devices," in Z. Biener and E. Schliesser, eds., *Newton and Empiricism* (Oxford, 2014), 223-261.
Charles T. Wolfe, "The organism as ontological go-between. Hybridity, boundaries and degrees of reality in its conceptual history," *Studies in History and Philosophy of Biological and Biomedical Sciences*, 48 (2014), 151-161.
Charles T. Wolfe & Motoichi Terada, "The animal economy as object and program in Montpellier vitalism," *Science in Context*, 21/4 (2008), 537-579.
Charles T. Wolfe & Sebastian Normandin, eds., *Vitalism and the scientific image in post-Enlightenment life science, 1800-2010* (Dordrecht, 2013).
John Zammito, "From Vital Materialism to Naturphilosophie: The Question of Historical Continuity," in Keith Baker and Jenna Gibb eds., *Life Forms in the Eighteenth Century* (Toronto, 2016), 70-91.