

Do organisms have an ontological status?

Charles T. Wolfe

Unit for History and Philosophy of Science

University of Sydney

charles.wolfe@sydney.edu.au

forthcoming in *History and Philosophy of the Life Sciences* 32:2-3 (2010)

Abstract

The category of ‘organism’ has an ambiguous status: is it scientific or is it philosophical? Or, if one looks at it from within the relatively recent field or sub-field of philosophy of biology, is it a central, or at least legitimate category therein, or should it be dispensed with? In any case, it has long served as a kind of scientific “bolstering” for a philosophical train of argument which seeks to refute the “mechanistic” or “reductionist” trend, which has been perceived as dominant since the 17th century, whether in the case of Stahlian animism, Leibnizian monadology, the neo-vitalism of Hans Driesch, or, lastly, of the “phenomenology of organic life” in the 20th century, with authors such as Kurt Goldstein, Maurice Merleau-Ponty, and Georges Canguilhem. In this paper I try to reconstruct some of the main interpretive ‘stages’ or ‘layers’ of the concept of organism in order to critically evaluate it. How might ‘organism’ be a useful concept if one rules out the excesses of ‘organismic’ biology and metaphysics? Varieties of instrumentalism and what I call the ‘projective’ concept of organism are appealing, but perhaps ultimately unsatisfying.

1.

What is an organism? There have been a variety of answers to this question, not just in the sense of different definitions (an organism is a biological individual; it is a living being, or at least the difference between a living organism and a dead organism is somehow significant in a way that does not seem to make sense for other sorts of entities, like lamps and chairs; it is a self-organizing, metabolic system; etc.) but more tendentially, in the

sense that philosophers, scientists, ‘natural philosophers’ and others have both *asserted* and *denied* the existence of organisms. And of course, the existence or better, the *reality* of organisms is intimately bound up with a host of other weighty matters, such as the emergence of biology as an autonomous discipline, and its subsequent efforts to maintain that autonomy; how to account for the *animate* dimension of animate beings, in the absence of a concept of immortal soul; and more recent debates both internal to biology and spanning fields such as the philosophy *of* biology, such as the status of genes, populations, ecosystems and so on. To inquire into the ontological status of organisms, in such a tense, overdetermined field of theories, polemics and associations is somehow already to seem to take a stand, much like those professional skeptics who never seem to be able to shake off their life-long obsession with the paranormal. That is, if we seek to dispel some of the confusion and categorize some of the different positions on the issue, we are already granting that there *could be* an ontological status of organisms; that the question makes sense.

Disciplinary boundaries are not easy to employ here, because in one generation thinkers are using ‘organism’ as a term directly derived from ‘natural philosophy’ with the (empirical, experimental) authority that this grants; in another generation it has become something fully ‘conceptual’, or even ideological, as when Hans Jonas, opposing the world of conscious organisms to the ‘dead’ world of mechanical Nature, insists that “the point of life itself” lies in “its being self-centered individuality”; Jonas calls this “the ontological concept of an individual, as against a merely phenomenological one” (Jonas 1966, 79). Here we are being told not just that organisms exist and we should not deprive them of their reality in favor of genes, molecules or conversely populations; we are being told that such deprivation is *wrong*, almost morally wrong, which is not so surprising if we consider that historically, the case can be made that ‘organism’ is initially a naturalistic substitute for ‘soul’ (in the Leibniz-Stahl debate of the late 17th and early 18th century). “The history of the concept of organism in the 18th century can be summed up as the search, by naturalists, physicians and philosophers, for replacements or semantic equivalents for the soul, which could account for the increasingly well-established fact of the functional unity of a system of integrated parts” (Canguilhem 1989, 551).

Organism is a hybrid concept, located from the outset between different kinds of practices, constantly shifting in between the factual and what one might call the supra-factual.

Organisms can thus be metaphysical; empirical-but-used-for-metaphysical-purposes; ideological; and restrictively biological concepts. They can be particular states of matter, or particular types of living beings chosen as experimental objects, like the fruit fly or *C. elegans*, which are ‘model organisms’; worse still, at least for the sake of finding a manageable ontological box in which to fit them, on some definitions “humongous fungi” weighing ten tons, coral reefs, ‘living, breathing’ termite mounds or forests qualify as organisms (Turner 2000, Wilson 2007, Bouchard 2009). So even a study limiting itself to the rhetoric of science would be very large¹; it is not surprising that a short but insightful study of its history in modern biology called the organism “biology’s phoenix” (Benson 1989).

To sort out the disappearances and returns of this hybrid, ‘phoenix’ concept, even in part, requires a combination of historical and critical analysis. The latter is not exactly identical with the type of analysis practiced by mainstream philosophy of biology, in which the task for the philosopher is indeed a kind of specialized conceptual analysis aiming at clarifying the implications and perhaps consequences of biological claims; so for instance, a recent and influential definition of the discipline explains that it is “concerned with those biological debates in which conceptual and empirical issues are so entangled that progress demands both scientific knowledge and the tools of philosophical analysis” (Stotz, Griffiths and Knight 2004, 647). I of course concur with this definition, but wish in addition to *locate* something about the concept of organism and to *critique* it. In that sense I take quite seriously the moral that “biology’s exciting conclusions do not follow from the facts alone” (Sterelny and Griffiths, 1999, 5).

The interpretive, conceptual, clarifying and evaluative task at hand is not then just a matter of drawing subjective philosophical conclusions from an objective scientific set of facts; it involves making (and again, evaluating) ontological claims about the nature of biological entities, which have an irreducibly normative component (in the sense that their activity is interrelated with the norms of such activity). There is a role for the philosopher in discerning what gets to count as “real patterns,” in Dennett’s suggestive phrase (Dennett 1991). But for various reasons, not least the ever-shifting definitions provided by ‘working biologists’ (embryological, genetic, molecular, ecological, and now systemic),

¹ See however Schlanger 1971, Schiller 1978 – which is in fact a polemic against the concept of organism despite its historical pretensions – and especially Cheung 2006 and 2010.

philosophical reflection may benefit in addition from some historical considerations – rather than trying to adjudicate between various aprioristic claims and/or scientific definitions. After all, as Manfred Laubichler noted in a review essay with the endearing title, “The Organism is dead. Long live the organism!” (Laubichler 2000), there have been many histories of the gene, and few, if any, histories of the organism (with the above-mentioned exception of Benson 1989, which is intended more as a programmatic statement).

In the next section (§ 2) I provide a brief overview of the emergence of the term and its ‘episodic history’ including in the 20th century, in order to further specify the problem of what sort of object we are addressing, which sort of discourse is meant to be authoritative (‘who owns it’), and so on. In section 3 I describe some of the polarizations that have arisen, and suggest some basic criteria a theory of organism needs to abide by if it is to be viable. In section 4 I turn to the varieties of mechanistic approaches to organism, including the complexified, organizational approach we owe to Claude Bernard, in contradistinction to the conception of organism as a kind of paramount subjectivity. In section 5 I introduce the distinction between Kant’s regulative approach to organism (which, I argue, can be extended through the work of Kurt Goldstein and Daniel Dennett) and the post-Kantian ontologization thereof. I extend this discussion in section 6, and introduce the distinction between *methodological* and *ontological* views of organism; but I quickly point out the insufficiency of such distinctions. In section 7 I discuss various conceptions of the ‘unity’ which is meant to characterize organisms, and conclude in section 8 with some critical reflections on holism and the theory of systems. Overall I argue for some combination of what I call the ‘projective’ view of organisms (Goldstein *et al.*) and the ‘organizational’ view, recently restated by William Bechtel.

2.

If we look at the historical context, the word emerges in the late 17th-early 18th centuries, in particular in the debate between Leibniz and the chemist and physician Georg-Ernest Stahl (the author in 1708 of a treatise entitled *On the difference between mechanism and organism*), who was the chief representative of the *animist* position, according to which all animate motions are explainable in terms of the soul (Duchesneau 1998, 335f.;

Duchesneau 2000). After this one doesn't find the term much used in our sense in which it is opposed, e.g., to 'machine' until the late 18th century: in Diderot and D'Alembert's *Encyclopédie* there are almost no occurrences of the term 'organism'; one finds the adjective 'organic', which dates back at least to the 14th century. And in several of its occurrences, 'organism' ("organisme") clearly does not yet have the sense we associate with it; the article "Fibre" speaks of "the organism or mechanism of these various parts" (Diderot and D'Alembert (eds.), 1751-1780, VI, 670); the vitalist physician Bordeu, in a late work, the *Recherches sur les maladies chroniques* of 1775, speaks in a way we would find strange or confusing today, of the "*organism* of the living body" (Bordeu 1818, vol. 2, 1024).

The technical term in the Enlightenment for 'physiological structure' was rather *organisation*, defined in the *Encyclopédie* as "arrangement des parties qui constituent les corps animés" (Diderot and D'Alembert (eds.), 1751-1780, IX, 629b); it is comparable, and related to, terms such as 'organized bodies' and 'animal economy', the latter designating both a kind of theoretical approach in medicine and physiology to the living body, and that body itself.² Even a work filled with teleology and purposiveness like Kant's Third *Critique* doesn't contain the term 'organism'; it only appears in his *Opus postumum*.³ Kant speaks instead of "organized bodies." Notice – and this illustrates the 'hybridity' of the concept – that the notion is located from the outset at the intersection of philosophical inquiry into the status of living beings (Leibniz, Kant) and properly biological reflection. The existence in addition of a variety of natural-philosophical works in this period, dealing with such topics, by authors such as Francis Glisson, Walter Charleton, Robert Boyle or Claude Perrault (Wolfe forthcoming 2010a), does not alter the fact of this hybridity.

Aside from the classical authors mentioned above (and I'll say more about Leibniz and Kant below), philosophers in the 20th century have had a certain interest in the concept of organism, especially phenomenologically motivated authors such as Kurt Goldstein, Hans Jonas, and on the other side of the Rhine, Henri Bergson, Gilbert Simondon, and Raymond Ruyer – all of whom argue for such a concept, although in different ways, as I shall

² On 'organisation' and 'organism' see Balan 1975, Figlio 1976, Guillo 2003, Wolfe 2004, Wolfe 2009, Cheung 2010; on the notion of the animal economy in vitalist medicine see Wolfe and Terada 2008.

³ See Debru 1980, Huneman 2007, and Huneman 2010.

discuss below (namely, some, like Goldstein articulate what I shall call a *projective* view of organism as a ‘construct with benefits’, so to speak, while others like Jonas or Ruyer seem to follow a line consonant with strong vitalism, in which the organism appears, not just ontologically specific but almost transcendent with regard to the rest of the natural world).⁴ And there was of course a significant group of biologists in England in the early decades of the century who were equally concerned with ‘organism’ and ‘holism’ (Haldane *et al.*, 1918), as well as geneticists who were, curiously enough, followers of Whitehead, including W.E. Agar, who late in his career wrote an entire treatise on organism (Agar 1943).

It is worth noting that contrary to what one reads often, including in the brief historical references in most contemporary philosophy of biology (including Gilbert and Sarkar 2000), holism was never intended by any of its early 20th-century founders such as Jan Smuts (Smuts 1926) to be synonymous with organicism or vitalism, for the simple reason that it seeks to find general organizational laws, inspired by physics, without insisting on the uniqueness of Life; it is the thesis of “global dependence.”⁵ But of course holism *could* be used to articulate organismic theory, and it was. The theoretical point that emerges from this early 20th-century historical context is that there are two distinct areas of tension: first, an older but enduring tension between mechanism and organism, in which each of these allows of different degrees of interpretation (see below § 4), and second a 20th-century tension between mechanists (‘reductionists’) and holists. Again, the two can sometimes coincide and form a battery of arguments in favour of ‘organicism’.

⁴ Ruyer, who in other respects was a significant philosopher, reads like the worst parts of Driesch when dealing with biological matters: he warns the reader that because of contemporary science we must choose between “a generalized ‘theory of organism’ and the theory of “a ‘generalized molecule’” (Ruyer 1952, 166); indeed, he regrets that molecular explanations do away with Drieschian entelechies by reducing embryo development to physicochemical laws (Ruyer 1946, 80). Even Bergson is too mechanistic and Cartesian for Ruyer, in the sense that he had an excessively spatial understanding of the body (Ruyer 1946, 30)!

⁵ So, e.g. Köhler’s Gestalt psychology is a form of holism, in which he tries to model psychological theory on the field theory of Faraday and Maxwell. Of course, there are also contradictory moments such as when the founder of systems biology, Ludwig von Bertalanffy, invokes holism as a total systemic standpoint (again, with no reference to any special status of living entities), but earlier says that it sheds particular light on embryology and how organisms are not mere machines (he refers both to their teleology and their ‘historical character’, a phrase we also find in Goldstein): von Bertalanffy 1933, 9, 33, 52; he wrote further essays on organismic theory later in life. In other papers from the early years of systems theory there is also the recognition that the boundaries of a system are subjective; hence the boundary between the living and the non-living is not the issue.

We are familiar with the story of the eclipse of organism concepts in twentieth-century biology, which has multiple possible causes, ranging from the rise of genetics (from Watson and Crick in 1953 to the Human Genome Project) to the emergence of evolutionary biology in its own right. At first the latter may seem like a more receptive environment for organism concepts, as has been argued in recent decades by various strands of developmentalist theories, but in a very basic sense evolutionary biology tends to combine a supra-organismal level such as populations with a sub-organismal level (genes); the organism no longer has much explanatory force here (Walsh 2010). In addition, faced with the molecularization of biological entities, it's not just that the organism might seem old-fashioned or in need of deflationary treatment; in addition, it seems to proclaim by its very name that it transcends the mechanistic, causal world, or equally problematic, that it introduces other forms of causality: circular, top-down, non-linear... This is partly captured in Haldane's quip which makes it sound like the harmless word 'organism' is in fact the mysterious technical term 'norganism': "but it's a *norganism*, my dear young fellow, a *norganism* !" (Haldane, in Huxley 1971, 138). Nowadays, "both scientists and philosophers take ontological reduction for granted... Organisms are 'nothing but' atoms, and that is that" (Hull 1981, 282). "Organisms have disappeared as the fundamental units of life. In their place we now have genes ..." (Goodwin 1994, 1).

At the very least, "the 'organism' turns out to be a highly contestable notion" (Sterelny and Griffiths 1999, 173). And yet, organisms are also 'paradigm cases' – of individuals, of purposive entities, without either of these notions having to rest on a particular restrictive definition of 'Life' versus 'non-Life'. The challenge for the philosopher is not just to 'pick out' features of these entities (or conversely, reject the entire idea) but to navigate in between the Charybdis of self-contented molecular reductionism, and the Scylla of knee-jerk, biophilosophical anti-reductionism. To inquire conceptually into the ontological status of organisms in this sense includes, as I indicated above, a critical and evaluative assessment of the overdeterminations, vocabulary shifts, and ideological commitments inherent in the notion. To be clear, I am not looking for a *definition* of organism, whether in strict descriptive terms, e.g., as a "self-maintaining, autonomous and physically bounded entity" (Ruiz-Mirazo, Etxeberria *et al.* 2000, 222), or in more metaphysical terms as "the only type of individual" that combines "functional and self-reproductive identity" at once (*ibid.*, 229); for definitions run the risk of reverting to the form of assertions such

as ‘the organism is essentially self-consciousness’ or ‘the organism is in its essence temporal rather than merely spatial’. Instead, I discuss attempts to describe the category of organism in less ‘definitional’ terms, either as forms of organization or as forms of projection (§§ 5-7).

3.

Is it possible to ‘evaluate the value’ or the legitimacy of the concept of organism? Yes, inasmuch as it expresses a polarization between two visions of what living beings are, which imply in turn two visions of human being, that is, two visions of the place of human beings in the natural world, and by that token, two ideological attitudes towards science. In that sense there are not two different sets of concepts, one philosophical, and one scientific. Whenever the term is used in any sense beyond the completely neutral one, e.g. saying how many microorganisms inhabit a given space, or which traits contribute to the fitness of an organism (cases in which organisms *per se* are not being distinguished from anything else), it possesses a kind of valuative dimension.

Thus the defender of the ‘*strong* concept’ of organism, not content to assert à la Heidegger that “science does not think” and end it there, will try and shift the conflict into the territory of science itself, within science itself, and will say that there should be a science of the organism itself, a holistic science, a ‘new paradigm’ (as was frequently proclaimed about chaos theory and then self-organization⁶⁶), which would overcome or refute the excessively reductionist paradigm due to the Scientific Revolution. In some narratives, including reductionist reconstructions of the history of biology provided by figures such as the biochemist Jacques Loeb (Allen 2005, and for a similar argument from a historian’s point of view, Schiller 1978), this paradigm is presented – positively of course – as being subsequently reinforced by the mechanization of the circulatory system with Harvey and Descartes, and Friedrich Wöhler’s synthesis of urea in 1828. The latter event signifies the artificial production of organic substance by non-organic components, which rendered the claim that the chemistry of the living body is categorically distinct from that of inanimate bodies, invalid (Brooke 1968, McKie 1944). In anti-reductionist narratives at least since Husserl’s *Crisis*, the Scientific Revolution is frequently taken as a target for demystifying

⁶⁶ In Küppers 1990, self-organization is presented as the greatest paradigm shift in science so far.

what should not have been demystified, and thus somehow severing the link between humanity and Nature, thus bringing about both the original ‘explanatory gap(s)’, the problem of qualia (which, it is true, *is* a Scientific Revolution invention – of Galileo’s), human alienation and the exploitation of Nature (Merchant 1980).

A less emotional version of this sort of narrative is the theoretical biologist Robert Rosen’s assertion that the Newtonian revolution erases the distinction between the organic and the inorganic: all material systems can be analyzed as groups of particles moving in force fields (with the relevant dynamical equations) (Rosen 1985, 167); Darwin and especially Claude Bernard would have been surprised to learn that they were working in a scientific context in which there no longer was any distinction between the organic and the inorganic! Faced with this gradual process of mechanization and molecularization, an eminent scientist like Niels Bohr can say: If you want to push the observation of an organism far as possible from the point of view of atomic theory, you will have to undertake an intervention that kills it.⁷ We often frequently encounter the judgment that so-called ‘quantitative’ approaches (whatever they may be) lack finesse and miss something crucial about the qualitative dimensions of experience (mind, life, consciousness, etc.); the quantitative approach will lack a ‘feeling for the organism’, to borrow Fox Keller’s (1983) phrase. Even when Jonas is avoiding overt normative language, he still declares that “waiving the intelligibility of life” (i.e., allowing the third-person descriptions of scientists to trump the fact of human “inwardness”) has the consequence of “rendering the world unintelligible as well” (Jonas 1966, 25).⁸

Whether or not one accepts the verdict of ‘mainstream science’ that the organism in itself either does not exist or does not matter (both molecular biology and evolutionary biology concur here in denying any inherent reality to the organism;⁹ think of Monod’s dictum that what holds for *E. coli* holds for the elephant), the problem is that most defenses or

⁷ Bohr 1993, 458a; Bohr 1961, 22. On Bohr’s anti-reductionism about biological entities see Hoyningen-Huene 1994.

⁸ Anti-reductionist arguments are usually answered either by saying ‘it works!’ (from medical materialism and psychophysics in the 19th century to molecular and genetic responses such as Loeb, Crick and Dawkins in the 20th century), or by showing how ‘mechanism’ as a concept and ‘mechanisms’ as things are more complex and diverse than the antireductionist thinks (Machamer, Darden and Craver 2000, Bechtel 2007, discussed below in § 4). It would be interesting in addition to show that the antireductionist’s history of science is often mistaken (cf. Thomson 1988, Gaukroger 2000, and Wolfe forthcoming 2010b for possible illustrations).

⁹ This maps onto Mayr’s distinction between functional and evolutionary biology; see Pradeu 2010.

challenges have something deeply value-laden about them. It is in the name of a certain idea of *value* that one defends a particularity of Life or living being; think of the expression ‘pro-life’! To that position which says that there is something about life which almost prior to argument is valuative, that is, normative in a desirable way, one can reply with Nietzsche’s comment in the *Gay Science* that “Life is not an argument. Among the conditions of life might be error” (Nietzsche 1882/2001, § 121, 117), a comment which resonates with the Epicurean, anti-teleological, anti-finalist tradition, but which can also be heard in Darwinian terms. We need to *evaluate this value* in order to see if a certain kind of suspicion towards techno-science, AI, Darwinism, reductionism in general is fully aware of what it is defending when it invokes the innate value of Life or living being (*le vivant, das Lebendige*); in addition, such criticisms generally fail to take account of the obvious fact that Darwinism in almost all its forms is an anti-reductionist discipline or set of disciplines, either because they confuse a debunking dimension – Dennett’s “universal acid” – with reductionism proper, or more confusingly, because they build a narrative of the “Death of Nature” sort (Merchant 1980) and view Darwin as having proposed “mechanisms” of life, hence completing the evil task begun by Descartes and others.¹⁰

If, at the conclusion of this investigation we still have a useful concept of organism, I suggest it would have to be compatible with the following three conditions:

- **First**, neither the human being nor the earthworm is, to speak with Spinoza, a dominion within a dominion, an ‘empire within an empire’ or ‘kingdom within a kingdom’ (*an imperium in imperio*, in Spinoza’s famous phrase from the Preface to Book III of the *Ethics*, in which he rejects the idea that we are somehow apart from the rest of Nature), including in the sense in which its interiority, subjectivity or intentionality would *in extremis* come and extract it from cold and inhuman (“mechanical”) causality; as Canguilhem put it in terms closer to von Uexküll’s *Umwelt*, “the environment of man’s sensitive and technical values is no more real, taken in itself, than the specific environment of the woodlouse or the gray mouse” (Canguilhem 1965, 154 ; cf. Wolfe, ms. 2009);

¹⁰ This goes hand in hand with the philosophically careless statement that Darwin was (for good or bad) the ‘Newton of a blade of grass’ that Kant had said could not exist. That Darwinism is in many ways anti-reductionist or at least at odds with traditional reductionist programs does not however entail Robert Rosen’s claim that “Evolution has come to do for biology today what vitalism did for it previously” (Rosen 1991, 255).

- **Second**, if the idea of reducing an x – here, an organism – to its components presents any danger, one would have to show *why*, rather than use the term ‘reductionism’ as a term of opprobrium. I am not saying that all critiques of reductionism are mistaken: indeed, below I will briefly try and present Kurt Goldstein’s careful and original arguments for his *projective* and *implicative* brand of holism *cum* anti-reductionism;
- **Third**, in an entirely physical universe composed of physical elements, their interactions and the effects of these interactions – in a universe in which, then, as Buffon says, “the organic is the most ordinary product of nature” (Buffon 1749, vol. 2, 39) – if the organism exists, it will not be as an entity existing beyond the physical, like a vital force outside of causality; there can be no particular ‘signature’ of entities like Walter Elsasser’s ‘organismic law’ of the 1960s (e.g. Elsasser 1964, 64; see also Elsasser 1961, 28, 30, 35). This is not to say that there is no “radical inhomogeneity” at “some level of organization” as he puts it (Elsasser 1964, 54, 63), but such special organizational definitions are precisely the sorts of “definitions” I said earlier I was not going to consider as viable answers, for categorical reasons.

On the contrary, given these conditions, if we continue to maintain a concept of organism, it would seem that it would have to be in a purely *instrumental* and *relational* sense – although there is something unsatisfying about the purely instrumentalist view, as I shall indicate in closing. When biology explains a phenomenon, what does it do? It seeks to identify the causes thereof and subsume them under *laws*. In a universe supposed to be exhaustively governed by the laws of physics, reduction is associated with the possibility of reducing the laws described by biology to the laws of physics and chemistry. The biologist could continue to speak of organisms or genes, but merely as conventional or instrumental terms. They belong (on this view) to an already superseded ontology. The question for the philosopher of biology would be: is this entity real or not? The instrumentalist position denies the essential existence of an entity apart from the physical universe, and insists that the ontological commitments of a science are conventional. I will accept this instrumentalist *proviso* but try and give it a slightly more operational meaning. That is, if the organism cannot claim to have a privileged status, as in the renewal of

Aristotelianism hoped for by some, in the wake of Marjorie Grene¹¹; if the organism cannot claim to be the basis for a holistic science, the goal of which, as I pointed out, is to defend some ‘value’ of living being faced with artificiality (cloning, biotechnology, and the like) or mechanization, it can still have an existence other than the limbo to which it is condemned in molecular biology.

For instance, one can argue for a concept of organism as possessing its own ‘historicity’ or ‘temporality’, which was expressed by Merleau-Ponty in very Goldsteinian terms as the *corps propre*, i.e. the type of relation I can have to my body which is not the same as the scientist’s; a certain kind, of private, ineffable relation – although Patricia Churchland has wittily challenged, not the existence of such relations but rather their uniqueness, pointing out in perfectly embodied fashion that we can claim to have a first-person, privileged relation to *all sorts* of physical things, including our stomach and bowels, in a state of “awareness of visceral circumstance” (Churchland 1988, 282). Similarly, as regards ineffable subjectivity, Bill Lycan notes that while it may be true that “I can refer to my pain using a concept that no one else can use to refer to my pain,” and a bat (in a well-known example) can also “refer to its sonar sensation using a concept that no human could use,” it does not however follow “that the bat knows or understands a *different fact*” (Lycan 1990, 121). The ontological status of organisms and debates about qualia, explanatory gaps and the ‘hard problem’ are less far removed than they might appear (this similarity at the level of subjectivity and inwardness is in addition to better-known shared problems such as the role of functions and teleological explanations, see Kraemer 1984). More recently Varela has also insisted on a kind of irreducible first-personness, under the influence of Merleau-Ponty, with a newer emphasis on the project of a ‘first-person science’.¹²

However much some elements of this phenomenological interpretation provide interesting material on how organisms construct their worlds, I would also advocate a healthy suspicion towards this reinvestment by phenomenology, inasmuch as in this discourse

¹¹ Contemporary calls to return to what is called an ‘Aristotelian’ perspective on nature over and against a perspective inherited from the Scientific Revolution include Jonas 1966, Grene 1968, and Kass 1999; Kass is a prominent bioethicist who calls Jonas “[his] first real teacher in philosophical biology” (Kass 1995, 4). Changeux makes a helpful comment on the absurdity of trying to “return” to Aristotelianism in science in Changeux and Ricoeur 2002, 206-207.

¹² Varela and Shear 1999; for useful criticisms of the idea of a first-person science see Dennett 2001.

‘organism’ seems to serve as an excuse to reiterate anti-naturalistic points about the ‘subject’ or ‘subjectivity’. There is a real anti-naturalist war machine in this tradition, launched by Husserl, perpetuating the old stiffness of the Cartesian *cogito* faced with the world of nature: “it is only when the mind ceases to naïvely turn towards the outside and returns to itself, in order to dwell in itself, purely in itself, that it can be self-sufficient” (Husserl 1970, 297; translation modified). The extreme form of this insistence on subjectivity and the opposition between flesh and body is Merleau-Ponty’s sacralization of the living organism, when he equates the sensation of an embodied being to a mystical communion with divine presence (Merleau-Ponty 1962, 212). Of the figures we shall discuss, neither Goldstein nor Varela share this extreme, almost mystical way of presenting the organism; however, Varela retains this old insistence on the sovereignty of the individual over and against what he perceives as an impersonal evolutionary process:

I maintain that evolutionary thought, through its emphasis on diversity, reproduction, and the species in order to explain the dynamics of change, has obscured the necessity of looking at the autonomous nature of living units for the understanding of biological phenomenology. Also I think that the maintenance of identity and the invariance of defining relations in the living unities are at the base of all possible ontogenic and evolutionary transformation in biological systems (Varela 1979, 5).

Goldstein, as I discuss below (§ 7), has moments where he speaks of the organism’s life as somehow out of ordinary time, reaching an almost eternal state of self-creation. It is clear that if such theories are to be pertinent in a broadly naturalistic sense, we need to add – aside from additional philosophical ‘translation’ – Darwinian constraints on Goldstein or Varela’s sheer positivity of organism: the organism is not a solitary, self-creating artist! Here the need becomes clear for a ‘dialectical’, ‘interactionist’ vision of organism which is Darwinian-compatible and (at least in part) for that reason not so solipsistic, along the lines of Lewontin’s view that “The environment is not an autonomous process but a reflection of the biology of the species. Just as there is no organism without an environment, so there is no environment without an organism” (Lewontin 1983/1985, 99).¹³

¹³ Lewontin’s ‘dialectical’ and Oyama’s ‘interactionist’ theories of organism and environment as systems are by no means the same, but they are frequently discussed together and for present purposes serve as ‘flagbearers’ of various movements to remove the organism from its Romantic solitude and consider it as one of many interacting entities (but without, conversely, reducing this process to a dematerialized, holistic theory either, as I discuss in closing). I am grateful to Thomas Pradeu for past conversations on these topics.

4.

To see how one might arrive at this understanding of organism, it is helpful to look historically again at how the notion appeared: it was, evidently one might say, against the background of, or in contradistinction to, the notion of *machine*. The mechanical philosophy – Boyle, Hobbes, Descartes but also iatromechanism as a research program in physiology and medicine, with figures such as Giorgio Baglivi and Hermann Boerhaave – rested on the notion that natural phenomena result from interactions between material particles governed by the laws of mechanics. This enabled the formulation of laws of motion and the invention of particular mechanisms (from clockwork to Vaucanson’s mechanical duck), the latter allowing one to explain particular phenomena. Baglivi stated in 1696 that he wanted to carry out a program which would demonstrate that “the human body is nothing other than a complex system of mechanical and chemical motions obeying mathematical laws” (Baglivi 1696, I, xi, §§ 6-7). In an equally influential 1703 lecture – explicitly entitled on “The Usefulness of the Mechanical Method in Medicine” – Boerhaave stated with even more ontological surety that “the human body is in its nature the same as the whole of the Universe which is open to our view” (Boerhaave 1703/1983, 96).

What’s curious is that biology – the science of life – emerges in this period; biology is constituted *for* and *by* a mechanical, mechanistic model which is itself blind to the concept of life; of course, the very fact that this model, or family of models, was so productive might lead one to suspect that the model was not so blind!¹⁴ This point has been nicely brought to light, specifically with regard to the Paris Académie des Sciences, by Salomon-Bayet (1978): the Académie is set up to investigate natural phenomena on a mechanistic, Cartesian basis and yet from the outset its own reports, on natural history, physiology, anatomy (including the famous “querelle des monstres,” see Wolfe 2005) contradicts that basis in all sorts of ways. Similarly, if one looked closely at La Mettrie’s famous

¹⁴ That the opposition between ‘machines and organisms’ or ‘mechanism and teleology’ is much less obvious than it appears, even in the early modern period, is a topic that goes beyond the scope of the present paper. Consider Boyle’s ‘hydraulic-pneumatic’ model for the human body (and his defence of final causes); even Cartesian mechanistic physiology, far from denying the existence of goal-directed processes, was in fact replete with functional language, e.g. when discussing the circulation of blood and the motion of heart. The Cartesian point (following a suggestion in Gaukroger 2000) is not that bodies actually are machines (an eliminativist view) but rather that the structure and behaviour of bodies are to be explained in the same way that we explain the structure and behaviour of machines (a reductionist view). See also Wolfe (forthcoming 2010a, 2010b).

L'Homme-Machine of 1748, one would find out that it is not really very mechanistic, at least in the traditional sense; that is, it aims at locating some of the physiological mechanisms particular to living, organic beings (Thomson 1988) without thereby eliminating all specifically organic properties in favour of mechanical ones (Wolfe forthcoming 2010b). More than a century later, Claude Bernard stated that scientifically, “we are right to treat the organism like a machine,” but he immediately introduces a somewhat puzzling distinction: we are “mistaken when we treat it as a *mechanical machine*, fixed and unchanging”; rather, “the organism is *an organic machine*, which possesses a flexible mechanism, thanks to special organic processes which exist therein; but these do not transgress any of the general laws of mechanics, physics or chemistry” (Bernard 1937, cit. in Canguilhem 1989, 552).

Physiologists such as Walter Cannon, theoretical biologists such as Francisco Varela and philosophers such as William Bechtel have, in their respective ways, each promoted this Bernardian concept of an “organic machine” (as a homeostatic, autopoietic or organizational whole comprised of micro-mechanisms), and indeed, we have here a rare case where the historical and the conceptual complexities seem to cohere, around the status of ‘mechanism’ (weak or strong), ‘mechanisms’ (as pluralistic) and ‘mechanical models’ (as essentially heuristic). The core insight I wish to derive from this is that *a mechanical model is nothing else than a heuristic model designed to explain something about the object which ‘organicists’ seek a monopoly on, namely Life*. Recent work on mechanism, like recent reevaluations of *organisation* or ‘animal economy’, tend to blur the divide between the two concepts.¹⁵ Mechanism, Bechtel suggests, can provide an adequate account of organization (a more structural word for ‘organism’) by “placing as much emphasis on understanding the particular ways in which biological mechanisms are organized as it has on discovering the component parts of the mechanisms and their operations” (Bechtel 2007, 270). There is an important dialectical relationship between the mechanistic explanatory programme to study (by reduction, modeling and componential analysis) the structures at work in organisms, and the organicist (vitalist, holist) standpoint which minimally “remind[s] mechanists of the shortfalls of the mechanistic accounts on offer,” for ideas such as “negative feedback, self-organizing positive feedback, and cyclic

¹⁵ Machamer, Darden and Craver 2000; Bechtel 2007; Wolfe and Terada 2008, §§ 4-6. For a contrary view, reiterating the value – scientific and philosophical – of the opposition, see Gierer 1996.

organization are critical to explaining the phenomena exhibited by living organisms” (*ibid.*, 296-297).

Vitalistically inclined figures such as Bichat and Bernard, in Bechtel’s argument (to which one can add the Montpellier vitalist Barthez a generation earlier), usefully formulate challenges to the mechanistic model (without, one might add, offering any foundationalist ontological rejection of it). Indeed, it is a characteristic trait of all these thinkers to reject their predecessors . . . as “vitalists,” obviously in a pejorative sense, and also target earlier (iatro-)mechanists such as Borelli or Boerhaave for not fulfilling their scientific obligations. Théophile de Bordeu, a prominent Montpellier vitalist physician, complained explicitly about the obscurantism of some his teachers in his 1775 *Recherches sur les maladies chroniques*: “We used to ask . . . what this vital principle that was responsible for night and day (*qui opère le blanc et le noir*), and governed that which was opposed to it” (Bordeu 1818, vol. 2, 972). But a short time later Cuvier includes Bordeu amongst the culprits: Stahlian animism, he claims, was taken on in modified form by the Montpellier vitalists; “in addition to the contradictions and metaphysical obscurity generated by a purported local sensibility without perception, which all these physicians found to exist in particular organs, and some still maintain, one can also reproach them for over-using [the notion of] what they termed the *vital principle*, using this occult entity quite vaguely, in order to attribute to it all the phenomena they found difficult to explain” (Cuvier 1810, II, 232). The point is not just that ‘vitalists’ frequently have to define themselves over and against vitalist predecessors, who they have to portray as being overly metaphysical and lacking experimental backing for their ideas; it is also that this rhetorical complexity is part of the nature of concepts such as ‘organism’ or ‘organization’, which are meant to explain the special features of living organisms, while also being concepts open to the mechanist (for further discussion of this sort of rhetorical tension surrounding terms like ‘vitalism’, see Oyama 2010).

An interesting point raised by Ruiz-Mirazo, Etxeberria *et al.* (the juxtaposition of the two points is mine, not theirs; Ruiz-Mirazo, Etxeberria *et al.* 2000, 231) is that organism may not be a necessary or necessarily interesting organizing point for biological inquiry, inasmuch as some biological fields will simply not need to make use of the concept, but that at the same time it is a kind of ‘primitive’ which cannot be reduced to its components, even if these are construed as mechanisms (which indeed we might construe in the above

sense of homeostatic wholes composed of various micromechanisms). Indeed, for every “uniquely biological concept” such as homeostasis (whether we take this as a merely empirical concept or in its more hypostatized forms as a kind of ontological ‘marker’ of Life), there is a deflationary, mechanistically specifiable concept that will match it, such as H. Ross Ashby’s ‘homeostat’; but this should not entail that we dispense with all properties of organisms in favour of the properties of familiar machines; rather, following intuitions of Boerhaave, La Mettrie, Bernard, mechanisms, organization and organisms should be understood more dialectically as *interrelated* concepts.

In sharp contrast to this vision in which organisms are real but not categorically separate from mechanisms, or, put differently, that their reality is ‘organizational’ rather than somehow ‘essential’, to the extent that a degree of interpretation (of projection, of heuristics) is incorporated in the concept of organism, we find the vision of organisms as paramount, embodied *subjectivities*. One must note that this is both equally compelling, equally congenial to common sense on some definitions (Dennett has written at great lengths about the ‘feeling’ we have that “someone is home” when we are faced with a human, an animal or a particularly mobile intentional agent of the robot variety), and has been espoused by a variety of important thinkers, as I indicate below. That does not mean it is a good argument, or a satisfactory picture of what organisms are.

When Kant famously declares that there will never be a Newton of a blade of grass (“it is absurd for human beings . . . to hope that perhaps some day another Newton might arise who would explain to us, in terms of natural laws unordered by any intention, how even a mere blade of grass is produced,” Kant 1790/1987, § 75, 282-283), or when Leibniz insists that the difference between a ‘machine of nature’ and an artificial machine is that a machine of nature, a living being, is a machine to infinity, they are both clinging to the idea of an invisible *inside* or *interiority* which constructions and reconstructions cannot grasp:

Moreover, by means of the soul or form there is a true unity corresponding to what is called the SELF [*moi*] in us; such a unity could not occur in artificial machines or in a mere mass of matter, however organized it may be; such a mass can only be considered as an army or a herd, or a pond full of fish, or like a watch composed of springs and wheels (Leibniz 1695/1978, 482).

This closely resembles the view known as ‘agent causation’ in action theory and moral philosophy more broadly. Just as the above descriptions of what a living agent (‘organism’) stress that its unity is derived from a particular type of selfhood or internal unity, versus the ‘masses’ or ‘aggregates’ encountered in physical nature overall, theorists of agent causation insist that acts flow from an agent in a way completely different to, and unexplainable in terms of, the causal processes at work in the rest of the natural world. Agent causation was a prominent view in action theory starting in the 1960s, and is sometimes traced back to Thomas Reid, but an early practitioner is in fact the Cambridge Platonist Ralph Cudworth, insisting in his posthumous treatise on free will that the soul exercises “hegemonic” control over itself; “ye whole Soule Redoubled upon it Selfe, which being as it were within it Selfe, and comprehending it Selfe . . . hath a *Sui potestas* over it Selfe, and can command it Selfe or turne it Selfe this way and that way” (Cudworth 1838, § X, 36). The organism as subjectivity is very much this self “redoubled upon itself,” which cannot be grasped by any componential analysis.

In contrast, the ‘artificialist’ position points to the heuristic dimension of a mechanism as being ‘built so as to see what’s inside it’ (in the sense articulated already by the physicist William Thomson: “I am never content until I have constructed a mechanical model of the object that I am studying. If I succeed in making one, I understand; otherwise, I do not”; Thomson 1884, 270; Cassirer 1950, 115). Obviously, an organism construed in *instrumental, relational* and *projective* terms is not so far removed from such a mechanism (I discuss some of the implications of the ‘projective’ concept of organism below, § 6). Does this prevent the biologist or the philosopher of biology from articulating ‘laws of life’? Not really. The specificity of life can be treated in functional terms, rather than arguing for a special *substance* (substantial vitalism). One can conceive of a *functional vitalism*, as Barthez (1806) did, using a Newtonian analogy: call the ‘vital force’ an X, an unknown, and that will allow me to formulate laws specific to living beings, without making any ontological claims as to this force. To be precise, overtly, Barthez says he will analyze the ‘something’ that differentiates living bodies from dead bodies *like one analyzes the “unknown quantities” of the geometricians*: “The thing found in living beings which is not found in the dead, we shall call Soul, Archaeus, Vital Principle, X, Y, Z, like the unknown quantities of the geometricians. We only need to determine the value of this unknown, the assumption of which facilitates and shortens the calculation of phenomena” (Barthez 1806, vol. 1, 16). The idea is that the relevant biological property will be treated

in the way that Newton treated gravity *epistemologically*, as “a (provisionally) inexplicable explicative device” (Hall 1968, 14).

We might recognize in this ‘functional vitalism’ a basic insight of functionalism in the philosophy of mind; but just as an *interrelated* concept of mechanism and organism allows one to retain a dimension of embodiment when dealing with mechanisms, and a dimension of structural or componential analysis when dealing with organisms, similarly, the defender of functional vitalism will still be preoccupied in explanatory terms with the fact that the systems she studies are ... alive, embodied in a particular kind of matter (Wolfe and Terada 2008). As I say below (§ 8) with respect to systems theories (a diverse family in which holism and functionalism can both be found), one must be careful not to leave out the matter.

5.

If the history of mechanisms and organisms shows a significant degree of interplay, with mechanical models of Life aiming after all to explain ... Life, and organismic theories in at least some cases (when they are not built on the foundations of non-spatial, extra-causal agents such as souls, entelechies or subjectivities) comprising organizational features, what about more theoretical approaches?

In more purely conceptual terms, there is no *a priori* criterion that allows one to distinguish a living being from a non-living being, whether the integrity of the organism, its self-regulation (homeostasis), or ‘metabolism’ (selected by Hans Jonas as a crucial distinguishing feature of organisms); after all, the defining claim of cybernetics was to have produced working models of just such features, rehabilitating ‘purposive’ concepts without any ‘vitalist’ overtones¹⁶). These features are always *post facto* observations, starting from within a temporal process. In that sense, the relation between living and non-living, organism and machine, is an *empirical* relation, which does not allow one to claim qualitative differences between laws of nature. As Rosen says, “there is as yet no list of tests, characteristics or criteria we can apply to a given material system that can decide

¹⁶ Wiener explicitly focused on Cannon’s idea of homeostasis when defining what he called “negative feedback” (Fox Keller 2008 and 2009); hence Ashby’s choice of the term ‘homeostat’ (Ashby 1948). Current cognitive science even discusses “homeostatic plasticity” in robots (Barandirian and Di Paolo 2010).

whether that system is an organism or not”; “the decision as to whether a given system is an organism is entirely a subjective, intuitive one, based on criteria that have so far resisted formalization” (Rosen 1985, 166-167).

In other words, given that the science of life is founded on mechanistic concepts which in and of themselves deny the specificity of life (even if these concepts or models, like Vaucanson’s duck, are also heuristic models of the complexity of living systems), its construction of a ‘boundary concept’ called ‘organism’ is necessarily *a posteriori*. What this entails is that any kind of strong (ontological) vitalism, strong claim about organism, essentialist-substantialist view, will be based on what is at best a heuristic fiction – which for some of us is not a problem! (Wolfe 2006)

When I say ‘heuristic fiction’ I have in mind the Kantian point concerning organism as a *regulative principle* (instantiating the idea of a natural purpose), a point reiterated in different ways by Goldstein and Dennett. Kant is extremely cautious about the possibility that “nature as a whole is an animal,” a giant organism, as it were: it does indeed help to support the hypothesis of the purposiveness of nature, but if we really believe it to be true we fall into a circle since we are attributing to Nature properties we know in organized beings, and can never know if it possesses these properties itself (Kant 1790/1987, § 73, 276). Epistemologically, the point one can derive from Kant, Goldstein and Dennett is that in order to be able to understand an entity we need to project certain features onto it; but these features should not be held to be constitutive of certain ‘regions’ of the real. Organism in this ‘Kantian’ vein is a regulative ideal in the sense that it is something posited as necessary for our intellects to be able to grasp a nightingale or an orang-outang (or even a blade of grass) as intentional agents; it is not a statement about the properties of the real. Much work has been done in recent years on Kant’s ideas and their significance for contemporary philosophy of biology (see Huneman (ed.), 2007); all I want to emphasize is that for Kant, organism is a “reflective” construct rather than a “constitutive” feature of reality, and reflective judgments are “incapable of justifying any objective assertions” (Kant 1790/1987, § 67, 259; § 73, 277).¹⁸

¹⁸ Of course the posterity of Kant’s ideas in biology has little to do with his own strictures on how to approach organic life: not only were the self-limitations of the critical philosophy ignored or deliberately reversed by Romantics, Naturphilosophen, ‘Idealists’ such as Hegel and Schelling (Huneman 2006); Kant has also served as a source of new biological ideas (including self-organization) repeatedly in the later 20th and early 21st centuries (e.g. Weber and Varela 2002), in ways he would not have approved of. Even Konrad

In the shift from Kant to Goldstein and Dennett, what is new is that it is *the organism itself* which is being credited with this *projective* capacity. It has also been argued that the similarity between Kant's 'regulative' idea and Dennett's intentional stance (Dennett 1987) indicates that Dennett's naturalism fails, or is inadequate (Ratcliffe 2001). As I indicate below, I think the idea that we – and other animals – are 'projectors', as it were, should not spell the end of any naturalistic project, except perhaps 1950s behaviorism. Dennett's intentional stance idea is meant to account for

the ability of animals to make reliable predictions about the behavior of others given their complete ignorance of the biological mechanisms that govern behavior. Since we ordinarily have no access to the internal mechanisms governing the behavior of our fellow creatures, we must adopt . . . the *intentional stance* towards them. [This] is a strategy that begins with the assumption that other animals (including people) tend to pursue outcomes that serve their interests and that they have been equipped by natural selection with suitable perceptual and cognitive capacities . . . (Symons 2002, 43).

In the case of Goldstein, there is more of an emphasis on the organism as a producer of intelligible totalities, as a system which actualizes itself and thereby enters into an adequate relation to its environment (Goldstein 1934/1995, 325). But in both cases there is a sense that our cognitive or perceptual make-up is necessarily 'organismic', and indeed its being so contributes to our aptitude for survival. In contrast, the genuinely Kantian view is not a description of any part of Nature itself; it is, depending on the context, an *epistemological* view but also what I've called a *projective* concept of organism.

Hegel and Schelling abandoned this Kantian self-limitation in their philosophies of nature as organism. Schelling described the organism as "the perfect mirror-image of the absolute in Nature and for Nature" (Schelling 1803/1988, 51). For Hegel and Schelling, the task of writing a philosophy of nature is in large part in order to articulate a philosophy of organism, as a cosmic principle, an account of the universe itself as organic. To illustrate this tension, one can think of Goethe's story in *Poetry and Truth* (chapter IX), in which he describes his excitement upon ordering d'Holbach's *System of Nature*, because of its title, which for Goethe implied an animate, pantheistic universe; when it arrived, he was

Lorenz was part of this trend, contributing an essay to the *Yearbook of the Society for General Systems Theory* on how to interpret Kant's notion of the a priori and the categories in the light of contemporary biology. Lorenz argues that the categories and our structures of perception overall are evolutionary adaptations of our nervous system to pressures of the real, natural world (Lorenz 1975).

horrified at this “dark and cadaverous work.”¹⁹ Goethe stands for philosophy of Nature as an attack upon mechanistic, quantitative science and its principle; he had mistakenly thought the *System of Nature* belonged to his intellectual family. This fits quite symmetrically with his response to Kant: “the *Critique of Judgment* fell into my hands and with this book a wonderful period came into my life” (“The influence of modern philosophy”, cit. in Huneman 2006, 665); Judith Schlanger says nicely that Goethe “overevaluated organicity as individual life” (Schlanger 1971, 108).²⁰

For different reasons – but always motivated by a certain concept of organism, usually buttressed by certain ‘empirical’ claims (about embryo development, metabolism or just the sovereignty of human beings in the natural universe, notably because of their particular mode of ‘awareness’ or ‘inwardness’), the same ‘ontologization’ of organism occurs in Driesch, Jonas, and those who favor a ‘revival of Aristotelianism’. While Jonas (and differently, Varela) are making claims about individuality and self-awareness, Driesch’s argument for the uniqueness of organism via entelechies is the classic case of scientific concepts that have been oddly hypostatized: while his experiments had shown that perfectly normal organisms could develop from embryos which had suffered from severe injuries produced by the experiment – thus, whole organisms resulted from abnormal growth conditions – Driesch derived from this the consequence that since the “formative power” at work is not interfered with by division, separation or displacement, “it must be a ‘something’ without spatial character and to which no definite position in space can be assigned”²¹; an entelechy.

Others (e.g. Schlick 1953, but also unexpected figures such as Bakhtin, see Bakhtin 1926/1992) have pointed to the mistakes in scientific reasoning here; I only wish to emphasize that Driesch is one of a variety of figures for whom the reality of organisms is an essential fact, including in the sense that it flows from their essence. The mistake that concerns us here is that of turning potentially significant facts about embryo development into ontologically irreducible features; and where Driesch posits an entity that actually

¹⁹ Goethe, *Dichtung und Wahrheit*, XI, in Goethe 1887-1919, pt. 1, vol. 28, 69.

²⁰ On the shift from regulative ideals to the ontologization of organism and/or vital force, see Larson 1979, Richards 2002, Reill 2005; for more on this aspect of Kantian thought cf. Huneman (ed.), 2007 and Huneman 2010.

²¹ Driesch 1908, I, B, “The Foundations of the Physiology of Development”: “Experiments on the Egg of the Sea-Urchin.”

does not exist, the entelechy, Jonas makes the same kind of mistake, but on the basis of features that do exist, such as metabolism and homeostasis. This is basically what D'Arcy Thompson criticized Haldane for: "The alleged phenomena of self-production, self-maintenance, and self-regulation are the common currency of those who, finding the mechanistic theory difficult and unsatisfactory, are content to postulate a something 'which interferes with and guides the physical and chemical reactions'" (D'Arcy Thompson, in Haldane, D'Arcy Thompson *et al.* 1918, 12). As I shall discuss below (and bearing in mind the description I gave of 'functional vitalism' in § 4), this form of 'ontologization' is to be opposed to the *projective* view of Kurt Goldstein (just as it is to Kant's view).

6.

One can distinguish, then, between

- a *methodological* (this is also the functional view, or what Goldstein calls 'constructivist' and I call 'projective') vision of organism
- and
- an *ontological* vision of organism (i.e. the ontologization of organism against which Kant argues)²²

However, I will not be content with reiterating this opposition, for both of these familiar positions suffer either from being impoverished or over-nourished. The methodological view is closely tied to the instrumental conception of biology, and even more closely tied to functional conceptions, which, as I discuss in closing, run the risk of leaving out the *matter* in which systems are realized entirely. And the ontological view tells us too much; it should be possible to argue for an ontological status of organisms, e.g. in Bernardian 'realist' terms, without being committed either to entelechies, contemplative inwardness, or eternal life.

²² This distinction unwittingly, but fittingly mirrors the first two out of three in Ayala's distinction between methodological, ontological and theoretical reduction (Ayala 1974), although the latter would probably find an analogue in programs such as systems biology (one can imagine correlating 'homeostatic property clusters' of different kinds of organismic wholes, real and simulated).

In the 20th century, the ontological vision is espoused variously by figures including Driesch, Jonas, and Ruyer. This tension between a methodological, constructivist view and an ontological, essentialist view also runs through a good deal of biological thought. For instance, the methodological vision is compatible with ‘functional vitalism’. The Vienna Circle critique, beginning with Schlick, targets Driesch for not respecting the causal closure principle. Rather than being content with this response to the vitalist, I’m interested in the instrumental notion, i.e., to speak with Dennett, my projection of intentional traits onto X serves an evolutionary purpose, rather than treating X as a mass of molecules; hence in this way the Kantian-Goldsteinian view can be augmented in Darwinian fashion, in which the capacity of certain types of embodied agents to project organismic features onto other agents would reflect some part of their evolutionary history. This Darwinian dimension additionally allows for an approach to organisms other than the once-omnipresent ‘non-reductive physicalism’: it does not force one to hold that higher-level entities such as tigers and buttercups are ‘constructs’ while the entities of physics are somehow more real (sometimes instrumentalist arguments rely on a kind of ‘lazy sophism’ gesturing towards a physicalist ontology, from which one gains little; cf. Wilson 2006).

When drawing distinctions between two ways of viewing the concept of organism, it is important to note that Goldstein himself – in what remains one of the major works on the topic – can be read both ways: on the one hand he defends a strong, Goethean-ontological view he calls ‘holistic’, and on the other hand, he articulates a heuristic/methodological perspective as an approach to the brain-damaged patient’s reconstituting of a personal ‘unity’.²³ Goldstein points empirically to the ‘fact’, the ‘property’ of our brains that they construct unity or totality, as a normal state but also in response to abnormal situations; but he also *ontologizes* this into a property of ‘the organism’ that somehow removes it from the world of causality and mechanistic natural science. However, he wants to go on calling this ‘biology’. Is he a vitalist? Clearly not in the sense of Driesch. And his concept of organism is not a self-production in the sense of a strong vitalism, since it’s an interplay or ‘debate’ (*Auseinandersetzung*) between internal needs and the environment (his “fundamental biological law” [*biologische Grundgesetz*], which Goldstein sometimes

²³ Much of Goldstein 1934/1995 is devoted to the problem. The first 2 chapters discuss empirical cases of brain-damaged patients in the process of rebuilding a sense of a ‘unified’ world; chapters 9 and 11 are particularly devoted to biological theory (parts and wholes, organic hierarchies, etc.).

equates with Wertheimer's 'prägnanz' or 'pregnanz' law in Gestalt psychology, even if he also expresses caution about applying the laws from one 'field' to another, and thus doesn't think one can directly have a Gestalt biology (Goldstein 1934/1995, 285).

However, contrary to Pavlov or Sherrington, Goldstein's holism describes behavior, not in a localized sense as a reaction to an event in the environment, but as a function of organic totality, or even a kind of "biological a priori" that the organism always strives to achieve or attain (hence his frequent reference to 'actualization' and 'self-actualization'), as an individual norm. There is something 'metaphysical' here. The position I'm terming 'instrumental', or 'methodological', 'constructivist', or above all, 'projective' benefits from insights drawn from the more methodologically oriented side of Goldstein's account. (No work that I am aware of brings out these two dimensions in Goldstein, certainly not the discussion of holism; Canguilhem's own 'philosophy of life', inspired by Goldstein, comes closer.²⁴)

At this point a word of clarification, or of stock-taking, is in order. It may seem as if I have continuously presented an opposition between two views, a strong and a weak view of organism, and illustrated how the strong view is committed to various kinds of anti-naturalistic and perhaps solipsistic tenets which make it difficult to embrace as a view of organism consonant with our 'best knowledge' of biological practice. While this may be true, the problem then remains as to what the weak view is, and if there is only one. Indeed, if we turn to 'weak' theories of organism, there is something very appealing about the *instrumental* view (organism is a useful concept inasmuch as it captures some of the empirical material we need to work out, but it can be discarded in favour of any other pragmatically useful concept; very much a *functionalist* view); and what I've called the *projective* view is partly related to this. The projective view, which I have attributed to Kant, Goldstein (in one of his moods) and Dennett, holds that organism is something we project onto the world, a kind of construction of intelligibility; it is then an *epistemological* version of the concept of organism, admittedly with a Darwinian twist when Dennett (partly anticipated by Konrad Lorenz, see Lorenz 1975) suggests that higher organisms *need* to be able to project what Goldstein would have called organismic totality onto certain types of agents, minimally for survival reasons, to which one could add various

²⁴ Canguilhem explicitly credits Goldstein with influencing him on this point in the essay "The Normal and the Pathological" (Canguilhem 2008, 129, 132). For further discussion of this relationship see Borck, Hess and Schmidgen (eds.) 2005, especially the contribution by A. Métraux, and Wolfe (ms., 2009)

accounts of sociality, ‘Machiavellian intelligence’ and the like. But none of these views give us any purchase on realist notions of the organism as they existed – without metaphysical underpinnings – in the work of major figures in the history of biology, such as Claude Bernard (see above, § 4). If we need such systems to make our theories come out right, then there is a sense in which organisms are part of our ontology, whatever the molecular stance may be.²⁵

7.

If the organism does not exist as such, there is no use in crying ‘reductionist!’... faced with de-naturing instances like cloning or prostheses! Much as Claude Bernard had stated that “there is only one physiology,”²⁶ we could broadly add that there are not two natures but one Nature. But isn’t there something that distinguishes higher organisms from the rest of the natural *imperium*? One can answer, with Goldstein, in the affirmative: individuality (Goldstein was in fact quite careful not to make claims for the uniqueness of human beings within the natural world, a mistake he diagnosed in the philosophical anthropology tradition). In a type of argument going back to Aristotle, the suggestion is: look around, and organisms are in fact the best candidates for individual substances. Organisms are “paradigmatic individuals,”²⁷ or, as Gilbert Simondon put it, the production of a living being is a process of individuation.²⁸ One could also adduce Claude Bernard’s notion of *milieu intérieur* and his insistence that the organism must be treated as an individuality: “the physiologist and the physician must never forget that the living being comprises an organism and an individuality . . . If we decompose the living organism into its various

²⁵ Thanks to Dominic Murphy for helping me see this more clearly.

²⁶ “Il n’y a qu’une seule manière de vivre, qu’une seule physiologie pour tous les êtres vivants” (Bernard 1885, 3^e leçon, “Division des phénomènes de la vie,” § III : “Réfutation générale des théories dualistes de la vie entre les animaux et les végétaux,” 148-149). Similarly, in his summary and presentation of Bernard’s lectures, Paul Bert denies that there could be “two contradictory natures giving rise to two opposed orders of science” (Bernard 1885, xxviii-xxix).

²⁷ Schlanger 1971, 42; Hull 1992, 182. On the individuality of organisms in a related sense see Symons 2010 and Pradeu 2010.

²⁸ Canguilhem and Simondon have in common the project of defending a particular notion of individuation within the biological realm itself, in the sense that ‘life is not possible without the individuation of living beings’. However, what distinguishes Simondon from this Goldsteinian trend is that he does not at all wish to reassert a metaphysics of the individual as an insurpassable term, but rather to ‘processualize’ the individual, to display the individual as the result of a process of individuation. For Simondon, it is not the individual who is the ground of the process of individuation, but rather individuation which grounds the individual.

parts, it is only for the sake of experimental analysis, not for them to be understood separately” (Bernard 1865/1984, II, ii, § 1, 137).

This individuality can also be conceived of phenomenologically, as I have mentioned earlier (§ 3), through the features of temporality and historicity, as in Goldstein’s statement “The organism is a historical being” (Goldstein 1934/1995, 387). Does Goldstein just mean that the organism has a capacity to provide adaptive responses to the ‘problems’ or ‘challenges’ posed by the environment, as it “selects” the relevant events occurring in that environment (84)? While he does say this, he also goes on in more ‘Goethean’ form (thereby matching the duality of methodological and ontological levels of his analysis that I described above) to say that “the organism is a being enduring in time,” and curiously enough “in eternal time, for it does not commence with procreation, certainly not with birth, and does not end with death” (387). We are reminded of his rather Romantic insistence on the organism’s perpetual self-actualization, which lacks a recognition of life’s more Darwinian challenges: “Life always has a positive character, it never manifests itself in negative terms” (388-389). Notice that, while Goldstein’s phrasing may make him seem remote at times from current biological theorizing, the view of the organism as a type of entity which either *can* be understood apart from evolutionary models and explanations, or indeed *should* be understood in such a way, is alive and well:

We cannot answer the question . . . ‘Why is a machine alive?’ with the answer ‘Because its ancestors were alive’. Pedigrees, lineages, genealogies and the like, are quite irrelevant to the basic question. Ever more insistently over the past century, and never more so than today, we hear the argument that biology is evolution; that living systems instantiate evolutionary processes rather than life; and ironically, that these processes are devoid of entailment, immune to natural law, and hence outside of science completely. To me it is easy to conceive of life, and hence biology, without evolution (Rosen 1991, 254-255; for a more cautious claim about understanding organisms apart from evolution see Wouters 2005).

This is not so different from Varela’s view, quoted above (§ 3), that living systems need not or should not be grasped in evolutionary **terms**. But here I wish to emphasize the more naturalistic part of Goldstein’s point: the organism not only responds to challenges in real time, but has a ‘temporal essence’. As Skarda and Freeman put it, the difference between biological agents and non-biological agents is that non-biological agents do not operate under global constraints (neural or ‘organismic’; for more discussion of the specific constraints operating in organisms see Mossio and Moreno 2010):

Storms, for example, are self-organized phenomena that can be mathematically modeled using the same principles we use to model neural dynamics. A storm takes in and gives out energy. . . . Storms, however, do not exhibit adaptive responses; . . . their system does not incorporate information about its environment. The storm may, for example, move towards land, but it does not do so under the constraint to survive as a *unity* (Skarda and Freeman 1987, 173).

Ruiz-Mirazo and Moreno call this ‘autonomy’ rather than the more broad ‘unity’: the capacity of a system to *manage* the flow of matter and energy through it so that it can, at the same time, regulate, modify, and control: (i) internal self-constructive processes and (ii) processes of exchange with the environment. Thus, the system must be able to generate and regenerate all the constraints –including part of its boundary conditions – that define it as such, together with its own particular way of interacting with the environment (Ruiz-Mirazo and Moreno 2004, 240).

The organism is a temporal-historical being in ‘dialogue’ with its environment. However, this approach at times risks breaching the Kantian limit, making organism a category of meaning or value from the outset, not *a posteriori*. One can hold its ‘unity’ (Skarda and Freeman), ‘autonomy’ (Ruiz-Mirazo and Moreno) or ‘totality’ (Goldstein) to be real without positing an essence, an ineffable ‘something’ threatened by a universe of measures and formalizations. Even the convinced reductionist should be able to accept the existence of a rudimentary teleology which ‘pulls’ the organism towards a desirable state, like homeostasis, and this opens onto a ‘systems’ perspective: von Bertalanffy felt that it was “hardly be a matter of dispute” that “phenomena in the organism are chiefly ‘whole-forming’ or ‘system-forming’ in character and that it is the task of biology to establish whether and to what extent they are so”; however, he acknowledged that the interpretive difficulty arises as soon as observers portray such forms of organization as embodying “will,” “purpose,” and “goals” (von Bertalanffy 1932, in Cassirer 1950, 215). To repeat a formulation I suggested above, one theorist’s ‘homeostasis’ is another theorist’s ‘homeostat’, that is, for every purportedly irreducible – and *real* – form of organismic unity, there will be a *model* which seeks to reproduce it.

However, contrary to defenders of the ontological vision of organism, I do not see any ‘danger’ in the mechanistic picture, which, as we recall, was the basis for the articulation of biology in the first place! Metaphysically, the position I am suggesting – Kant read a

certain way, Goldstein read a certain way – is that the ‘form’ of life is there *for us*. It’s a heuristic construction, a projection which reflects our desire to understand x as a totality. That we are, by dint of our nervous systems, ‘projectors’ does not mean we project any structure we choose onto the world: “To understand is always to construct a (meaningful) totality.”²⁹ And as this is to be taken in intersubjective terms, there is no need to postulate a hidden interiority. Recall that ‘organism’, as a way of designating internal unity, served as a substitute for ‘soul’, once there was no ‘ghost in the machine’ to explain animation. It was exactly in those terms that Leibniz spoke of organisms, as quoted above (§ 4): opposing the internal unity of organisms to the scattered ‘heaps of matter’ or at best aggregates existing in the rest of the universe.

8.

If we subject the concept of organism to the three ‘monistic’ conditions outlined in § 3, the result is two somewhat disparate traits: **(a)** organisms are real inasmuch as they exhibit certain forms of Bernardian, organizational unity and are not just *façons de parler*, verbal constructs (it is not just ‘handsome is as handsome does’, i.e., defining an organism as ‘whatever we project onto it’); but **(b)** part of their reality is to be ‘projectors’, to create intelligibility. In that sense one might speak of a production of a vital artificiality (Wolfe 2006). This is not a self-production in the sense of a strong vitalism, since it’s an interplay or ‘debate’ between internal needs and the environment, a dynamic equilibrium along the lines of Goldstein’s “fundamental biological law,” interrelating the organism’s self-actualization and the stimuli and constraints received from the environment. Far from being an appeal to a mysterious substance or ‘wonder tissue’, this sense of a stable process of self-actualization is very close to what we would call today a definition of organism in terms of its “causal closure,” a process of modulation whereby organism:environment interactions are modulated so as to maintain the conditions under which the agent can retain those very interactions.³⁰

²⁹ Starobinski 1956, 5, 11; Goldstein 1934/1995, chap. 9. See also Barbaras 1999.

³⁰ Goldstein 1934/1995, 101, 103, 107, 293; Christensen and Hooker 1998; on organizational constraints see Ruiz-Mirazo, Etxeberria *et al.* 2000; Ruiz-Mirazo and Moreno, 2004; Mossio and Moreno 2010; Nuño de la Rosa 2010.

This reconstructed concept of organism does not repeat the existentialist *leitmotive* of subjectivity, possibility, and mortality (even if, of course, we allowed for a *temporal* dimension of organism which implies the ‘sting’ of mortality³¹). After all, this ‘fundamental biological law’ of interchange between an internal system and its own environment, being an inherently *relational* concept, is doubtless expressible in ‘structural’ terms, so that organisms can only be ‘paradigmatic individuals’ in and through such a ‘debate’ or ‘relation’ to a population, a group or an environment as a whole (Lewontin 1983/1985, Oyama 2000).

But an apposite danger awaits the biological theorist who has fully desubstantialized her concept of organism, ridding it both (if it bears saying) of metaphysical flourishes like entelechies or *élans vitaux* and of category mistakes such as the assertion that the organism’s self-maintenance, or unity, or metabolic transformation are markers of the uniqueness of Life. She may arrive at a rather dematerialized form of holism, in which the emphasis on relations causes one to lose sight of the biological. At first it sounds perfectly plausible, if residually idealistic, to ask, like Paul Weiss, “Of what do we deprive a system when we dismember it and isolate its component parts, whether bodily or just in our mind? Plainly, of the *interrelations* that had existed among the parts while they were still united” (Weiss 1967, 802), although this runs directly counter both to the old sense of mechanism as building a model in order to understand one’s object (cf. Thomson 1884), as a form of ‘maker’s knowledge’, and to more recent discussions of a kind of expanded, pluralistic sense of mechanism (Machamer, Darden and Craver 2000). The real problem with this kind of approach – systemic, processual, **relational**, etc.; we could just say *holistic* – comes out more sharply in the formulation proposed by Robert Rosen, namely, that the reductionist approach to living systems is to “throw away the organization and keep the underlying matter,” whereas what he calls, following Nicolas Rashevsky, the “relational approach” in biology, recommends that “when studying an organized material system,” one should “throw away the matter and keep the underlying organization” (Rosen 1991, 119, sounding much like Varela and Maturana claiming that to understand machines we must disregard their *materiality*: Varela and Maturana 1972, 380).

³¹ Thinking of Jonas’ comment that Whitehead’s philosophy of organism lacks any awareness of death: “Death, where is thy sting?” (Jonas 1966, 96).

This is really both anti-materialist and ‘informational’ in an obsessive way (see Oyama 2000 and 2010 for some reflections on the *non-dits* of the informational perspectives in biology). Ironically, this is the sort of mistake the early Montpellier vitalists protested about with respect to anatomy, which had had so much success in the century prior to their writings (the 16th and 17th primarily): that it gave the investigator much information about structure and nothing about the functioning of the living animal or human. Varela is quite blunt in his disregard for the material in which a system is realized: “We are thus saying that what defines a machine’s organization is relations, and hence that the organization of a machine has no connection with materiality, that is, with the properties of the components that define them as physical entities. In the organization of a machine, materiality is implied but does not enter *per se*” (Varela 1979, 9, cit. in Bechtel 2007, 294).³²

Holism then suffers from a general weakness and a more specific problem. The more generic worry about holism and its ‘relational’ emphasis was stated by Russell: “if all knowledge were knowledge of the universe as a whole, there would be no knowledge” (Russell, in Phillips 1976, 11). We could call this the *epistemological* criticism of holism. A more ontological criticism would be to say that a mistake has been made about what wholes *really are*:

. . . the Whole itself is a product, produced as nothing more than a part alongside other parts, which it neither unifies nor totalizes, though it has an effect on other parts simply because it establishes aberrant paths of communication between noncommunicating vessels, transverse unities between elements that retain all their differences within their own particular boundaries (Deleuze and Guattari 1973/1977, 42).

Granted, this seems to disregard the difference between different kinds of wholes, but it serves as a (mechanistic) reminder not to overemphasize the value of the concept ‘whole’: brains, organisms and persons are wholes, to be sure, but so are lots of other entities, and conversely, different kinds of mechanist, componential, reductionist analysis tell us a lot about all of these wholes. But the more specific problem as it appears in the above quotations from Rosen and Varela is the complete disregard – it’s even recommended! –

³² Of course the dematerialized view also has some serious philosophy on its side (compare Symons 2010): “Many organisms totally exchange their substance several times over while they retain their individuality. Others undergo massive metamorphosis as well, changing their structure markedly. If organisms are paradigm individuals, then retention of neither substance nor structure is either necessary or sufficient for continued identity in material bodies” (Hull 1992, 182).

for the material facts about the living system being studied. The Bernardian approach to ‘organization’ and its contemporary reconstruction by Bechtel seems an obvious response, which precisely insists that one should *not* “throw away the matter” (contra Rosen). Notice that the second problem I have pointed to in holism/system theory exists in much the same form in functionalism: the disembodied tendency in multiple realizability arguments in which, as Putnam put it, “we could be made of Swiss cheese and it wouldn't matter” (Putnam 1975, 291). Instead, we need to recognize that even the vitalist cannot ignore the biological matter in which a system is realized – the ‘organizational features’ of a system.

That said, there are versions of the ‘systems’ view which are consonant with my monistic criteria in § 3: “*system thinking* does not imply forgetting about the material mechanisms that are crucial to trigger off a biological type of phenomenon/behavior; rather, it means putting the emphasis on the interactive processes that make it up, that is, on the dynamic organization in which biomolecules (or, rather, their precursors) actually get integrated” (Ruiz-Mirazo and Moreno 2004, 238). This helps bridge the gap between the systems perspective and the more materialistic, embodied ‘organizational’ perspective. The latter perspective seems to make the best of both worlds – mechanism and organism – without relying on a superannuated ontology, but also without opting for the non-committal comfort of pure instrumentalism. In addition, this perspective seems to capture something worthwhile about the history – as seen with Bichat and Bernard in Bechtel’s presentation, to which I added the 18th century medical vitalists. What is missing from this view is the ‘projective’ aspect which I reconstructed primarily from Goldstein’s rather suggestive discussion of organism.

Our inquiry into organism has produced two negatives and two positives: concepts of organism to be *rejected* include ones which invoke theoretical entities such as organismic laws: this is a kind of category mistake and probably scientifically of little use, and also ones which rely on a kind of ineffable subjectivity to justify the uniqueness of organisms. We could add the problem of the forms of holism which dispense with materiality altogether but, as I noted at the beginning (§ 2), in some basic sense holism never intended to be a specific theory of what living being is, even though the words ‘holism’ and ‘organicism’ have blurred into each other over time. Concepts of organism to be *accepted*, or integrated, include the Goldsteinian projective view (especially if it is mitigated with broadly ‘Darwinian’ constraints), the non-metaphysical, functional vitalism of the 18th

century (in which organism or rather the ‘animal economy’ and ‘organized bodies’ are explanatory targets without any ontological baggage), and the Bernard-Bechtel organizational view.

If, contrary to what strong ontological vitalism might assert, there is nothing unique and special about organisms over and against the rest of Nature; if, as Buffon thought, “the organic is the most ordinary product of nature,” what *does* exist is a certain approach to reality, the projection of heuristic fictions which produce intelligibility and promote viable courses of action. What remains to be done is (for instance) to articulate this philosophical position with work on biological organization.

Acknowledgments

This paper has been presented in different forms at ISHPSSB, CIRST (UQAM, Montréal), the Max-Planck Institut für Wissenschaftsgeschichte (Berlin), the Centre Cavallès (ENS, Paris), IHPST (Paris), and the Philosophy Department of the University of Sydney. My thanks to Alexandre Métraux, John Symons and Elke Witt for feedback on a much earlier version of the paper; to Philippe Huneman and Dominic Murphy for helpful suggestions at a penultimate stage.

References

- Agar, W.E., 1943, *A Contribution to the Theory of the Living Organism*. Melbourne: Melbourne University Press.
- Allen, G. E., 2005, “Mechanism, vitalism and organicism in late nineteenth and twentieth-century biology: the importance of historical context”, *Studies in History and Philosophy of Biological and Biomedical Sciences*, 36: 261-283
- Ashby, W.R., 1948, “The Homeostat”, *Electron* 20: 380.
- Ayala, F., 1974, “Introduction”. In Ayala F., Dobzhansky, T. (eds.), *Studies in the philosophy of biology*. Berkeley: University of California Press, vii-xiv.

- Baglivi, G., 1696, *De praxi medica ad priscam observandi rationem revocanda*. Rome: A.D. Ercole.
- Bakhtin, M., 1926/1992, “Contemporary Vitalism”, translation in Burwick, F., Douglass, P. (eds.), *The crisis in modernism. Bergson and the vitalist controversy*, Cambridge: Cambridge University Press, 76-97.
- Balan, B., 1975, “Premières recherches sur l’origine et la formation du concept d’économie animale”, *Revue d’histoire des sciences*, 28: 289-326.
- Barandiaran, X., Di Paolo, E.A., 2010, “Homeostatic plasticity in robots”, 4th International Conference on Cognitive Systems (CogSys), ETH Zürich, January 27-28.
- Barbaras, R., 1999, “The Movement of the Living as the Orignary Foundation of Perceptual Intentionality”, trans. C.T. Wolfe. In Petitot J., Varela F. *et al.* (eds.), *Naturalizing Phenomenology: Issues in Contemporary Phenomenology and Cognitive Science*, Stanford: Stanford University Press, 1999, 525-538.
- Barthez, P.-J., 1778/1806, *Nouveaux éléments de la science de l’homme*, Montpellier: J. Martel aîné; 2nd revised edition, Paris: Goujon & Brunot.
- Bechtel W., 2007, “Biological mechanisms: Organized to maintain autonomy”. In: F. Boogerd, F.J. Bruggeman, J-H.S. Hofmeyr, and H.V. Westerhoff (eds.), *Systems Biology: Philosophical Foundations*, Amsterdam: Elsevier, 269-302.
- Benson, K.R., 1989, “Biology’s ‘Phoenix’: Historical Perspectives on the Importance of the Organism”, *American Zoologist*, 29(3): 1067-1074
- Bernard, C., 1865/1984, *Introduction à l’étude de la médecine expérimentale*, préface de F. Dagognet, Paris: Flammarion.
- Bernard, C., 1885, *Leçons sur les phénomènes de la vie communs aux animaux et aux végétaux* (1878-1879), 2nd edition, vol. 1, Paris: J.-B. Baillière et fils.
- Bernard, C., 1937, *Pensées: Notes détachées*. Paris: J.-B. Baillière et fils.
- von Bertalanffy, L., 1932, *Theoretische Biologie*, Vol. I, Berlin: Borntraeger.
- Boerhaave, H., 1703/1983, “Oration on the Usefulness of the Mechanical Method in Medicine”. In *Boerhaave’s Orations*, trans. & ed. E. Kegel-Brinkgreve & A.M. Luyendijk-Elshout, Leyden: E.J. Brill / Leyden University Press, 90-120.
- Buffon, G.-L.L. de, 1749, *Histoire naturelle*, 15 vols., Paris: Imprimerie Royale.
- Bohr, N., 1933, “Light and Life”, Part 2, *Nature*, 133: 457-459

- Bohr, N., 1961, *Atomic Theory and the Description of Nature*, Cambridge: Cambridge University Press.
- Borck, C., Hess, V., Schmidgen, H., Hrsg., 2005, *Maß und Eigensinn. Studien im Anschluß an Georges Canguilhem*, München: Wilhelm Fink.
- Bouchard, F., 2009, "Understanding colonial traits using symbiosis research and ecosystem ecology", *Biological Theory*, 4(3): 240-246.
- Bordeu, T. de, 1818, *Œuvres complètes*, précédées d'une Notice sur sa vie et ses ouvrages par Monsieur le Chevalier de Richerand, 2 vols., Paris: Caille et Ravier.
- Brooke, J.H., 1968, "Wöhler's Urea and the Vital Force. A Verdict from the Chemists". *Ambix*, 15: 84-114
- Canguilhem, G., 1965, *La connaissance de la vie*, revised edition, Paris: Éditions Vrin.
- Canguilhem, G., 1989, "Vie", *Encyclopedia Universalis*, 23: 546-553.
- Canguilhem, G., 2002, "Le problème des régulations dans l'organisme et la société", in Canguilhem, *Écrits sur la médecine*, Paris: Éditions du Seuil, 101-125.
- Canguilhem, G., 2008, *Knowledge of Life*, trans. S. Geroulanos and D. Ginsburg, New York: Fordham University Press. (Translation of Canguilhem 1965).
- Cassirer, E., 1950, *The Problem of Knowledge*, trans. W.H. Woglom and C. W. Hendel, New Haven: Yale University Press.
- Changeux, J.-P., Ricoeur, P., 2002, *What Makes Us Think?*, trans. M.B. DeBevoise, Princeton: Princeton University Press.
- Cheung, T., 2006, "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): 319-339.
- Cheung, T., 2010, "What is an 'organism'? On the occurrence of a new term and its conceptual transformations 1680-1850", *History and Philosophy of the Life Sciences*, special issue on *The Concept of Organism: Historical, Philosophical, Scientific Perspectives*, Huneman, P., Wolfe, C.T. (eds.), 32(2-3), pp.
- Christensen, W.D., Hooker, C.A., 1998, "From cell to scientist: toward an organisational theory of life and mind". In Bigelow, J. (ed.), *Our Cultural Heritage*. Canberra: Australian Academy of Humanities, 275-326.

- Churchland, P.S., 1988, "Reduction and the neurobiological basis of consciousness". In Marcel, A., Bisiach, E. (eds.), *Consciousness and contemporary science*, Oxford: Oxford University Press, 273-304
- Cudworth, R., 1838, *A Treatise of Freewill* (ed.) J. Allen, London: John W. Parker.
- Cuvier, G., 1810, *Rapport historique sur les progrès des sciences naturelles depuis 1789, et sur leur état actuel*, Paris: Imprimerie Impériale.
- Debru, C., 1980, "L'introduction du concept d'organisme dans la philosophie kantienne", *Archives de philosophie*, 43(3): 487-514.
- Deleuze, G., Guattari, F., 1973/1977, *Anti-Oedipus: Capitalism and Schizophrenia*, trans. R. Hurley et al., New York: Viking Press.
- Dennett, D.C., 1987, *The Intentional Stance*, Cambridge, Mass.: MIT Press.
- Dennett, D.C., 1991, "Real Patterns", *Journal of Philosophy*, 88(1): 27-51.
- Dennett, D.C., 2001 (online ms.), "The Fantasy of First-Person Science", <http://ase.tufts.edu/cogstud/papers/chalmersdeb3dft.htm>
- Diderot, D., D'Alembert, J. (eds.), 1751-1780/1966, *Encyclopédie, ou dictionnaire raisonné des sciences, des arts et des métiers*, 35 vols., Paris: Briasson; reprint, Stuttgart/Bad Cannstatt: Frommann-Holzboog.
- Driesch, H., 1908, *The Science and Philosophy of the Organism*, Gifford Lectures for 1907, London: Adam & Charles Black.
- Driesch, H., 1914, *The History and Theory of Vitalism*, trans. C.K. Ogden, London: Macmillan.
- Duchesneau, F., 1998, *Les modèles du vivant de Descartes à Leibniz*, Paris: Vrin.
- Duchesneau, F., 2000, "Stahl, Leibniz and the Territories of Soul and Body". In Wright J.P. & Potter P. (eds.), *Psyche and Soma. Physicians and Metaphysicians on the Mind-Body Problem from Antiquity to the Enlightenment*, Oxford: Clarendon Press, 217-235.
- Elsasser, W.M., 1961, "Quanta and the concept of organismic law", *Journal of Theoretical Biology*, 1(1): 27-58.
- Elsasser, W.M., 1964, "Synopsis of organismic theory", *Journal of Theoretical Biology*, 7(1): 53-67.
- Figlio, K.M., 1976, "The metaphor of organization: an historiographical perspective on the bio-medical sciences of the early nineteenth century", *History of Science*, 14(1): 17-53.

- Fox Keller, E., 1983, *A Feeling for the Organism: the Life and Work of Barbara McClintock*, New York: W. Freeman.
- Fox Keller, E., 2008, "Organisms, Machines, and Thunderstorms: A History of Self-Organization, Part One", *Historical Studies in the Natural Sciences*, 38(1): 45-75.
- Fox Keller, E., 2009, "Organisms, Machines, and Thunderstorms: A History of Self-Organization, Part Two. Complexity, Emergence, and Stable Attractors", *Historical Studies in the Natural Sciences*, 39(1): 1-31.
- Gaukroger, S., 2000, "The resources of a mechanist physiology and the problem of goal-directed processes". In Gaukroger, S., Schuster, J. & Sutton, J. (eds.), *Descartes' Natural Philosophy*, London: Routledge, 383-400.
- Gayon, J., 1998, "La philosophie et la biologie", in *Encyclopédie philosophique universelle*, dir. J.F. Mattéi, vol. IV: "Le discours philosophique", Paris: PUF, 2152-2171.
- Gierer, A., 1996, "Organisms-Mechanisms: Stahl, Wolff and the Case against Reductionist Exclusion", *Science in Context*, 9(4):511-528.
- Gilbert, S., Sarkar, S., 2000, "Embracing Complexity: Organicism for the 21st Century", *Developmental Dynamics*, 219: 1-9.
- Goethe, J.W. von, 1887-1919, *Goethes Werke*, hrsg. im Auftrage der Grossherzogin Sophie von Sachsen, 143 vols, Weimar: Hermann Böhlau.
- Goldstein, K., 1934/1995, *The Organism: a holistic approach to biology derived from pathological data in man*, reprint, New York: Zone Books / MIT Press.
- Goodwin, B., 1994, *How the Leopard Changed its Spots: The Evolution of Complexity*, New York: Scribner's.
- Grene, M., 1968, *Approaches to a Philosophy of Biology*, New York: Basic Books.
- Guillo, D., 2003, *Les figures de l'organisation. Sciences de la vie et sciences sociales au XIX^e siècle*, Paris: PUF.
- Haldane, J. S. D'Arcy Thompson, W., Chalmers Mitchell, P., Hobhouse, L. T., 1918, *Symposium: Are Physical, Biological and Psychological Categories Irreducible?*, *Proceedings of the Aristotelian Society, Supplementary Volumes*, Vol. 1: *Life and Finite Individuality*, 11-74.
- Hall, T.S., 1968, "On biological analogs of Newtonian paradigms," *Philosophy of Science*, 35(1):6-27

- Hoyningen-Huene, P., 1994, "Niels Bohr's Argument for the Irreducibility of Biology to Physics". In Faye, J., Folse, H. (eds.), *Niels Bohr and Contemporary Philosophy*, Boston Studies in the Philosophy of Science, Dordrecht: Kluwer, 231-255.
- Hull, D.L., 1981, "Philosophy and biology". In Fløistad, G. (ed.), *Contemporary philosophy: a new survey*, vol. 2, The Hague: Martinus Nijhoff, 281-316.
- Hull, D.L., 1992, "Individual". In Fox Keller, E. & Lloyd, E. (eds.) *Keywords in Evolutionary Biology*, Cambridge, Mass.: Harvard University Press, 180-187.
- Huneman, P., 2006, "Naturalising purpose: From comparative anatomy to the 'adventure of reason'", *Studies in History and Philosophy of Biological and Biomedical Sciences*, 37: 649-674.
- Huneman, P., 2010, "Assessing the prospects for a return of organisms in evolutionary biology", *History and Philosophy of the Life Sciences*, special issue on *The Concept of Organism: Historical, Philosophical, Scientific Perspectives*, Huneman, P., Wolfe, C.T. (eds.), 32(2-3): pp.
- Huneman, P. (ed.), 2007, *Understanding purpose: Kant and the philosophy of biology*, North American Kant Society Studies in Philosophy, Rochester: University of Rochester Press.
- Husserl, E., 1970, "Philosophy and the Crisis of European Humanity". In Husserl, *The Crisis of European Sciences and Transcendental Phenomenology*, trans. D. Carr, Evanston: Northwestern University Press, 269-299.
- Huxley, J., 1971, *Memories*, New York: Harper & Row.
- Jonas, H., 1966, *The Phenomenon of Life. Towards a Philosophical Biology*, New York: Harper & Row / Dell.
- Kant, I., 1790/1987, *Critique of Judgment*, trans. W. Pluhar, Indianapolis: Hackett.
- Kass, L.R., 1995, "Appreciating The Phenomenon of Life", *Hastings Center Report*, 25(7): 3-12.
- Kass, L.R., 1999, *The Hungry Soul: Eating and the Perfecting of Our Nature*, Chicago: University of Chicago Press.
- Kraemer, E., 1984, "Teleology and the Organism/Body Problem", *Metaphilosophy* 15(1): 45-54.

- Küppers, B.-O., 1990, "On a Fundamental Paradigm Shift in the Natural Sciences". In Krohn, W., Küppers, G., Nowotny, H. (eds.) *Self-organization. Portrait of a Scientific Revolution*. Dordrecht / Boston: Kluwer, 51-63.
- Larson, J., 1979, "Vital forces: Regulative principles or constitutive agents? A strategy in German physiology, 1786-1802", *Isis*, 70: 235-249.
- Laubichler, M., 2000, "The Organism is dead. Long live the organism!", *Perspectives on Science*, 8(3): 286-315.
- Leibniz, G.W., 1695/1978, *Système Nouveau de la nature et de la communication des substances aussi bien que de l'union de l'âme avec le corps*, in Leibniz, *Die Philosophischen Schriften*, ed. G.J. Gerhardt, vol. 4, Reprint, Hildesheim: Georg Olms, 471-504.
- Lewontin, R.C., 1983/1985, "The Organism as the Subject and Object of Evolution". Reprinted in Levins, R., Lewontin, R.C., *The Dialectical Biologist*, Cambridge, Mass.: Harvard University Press, 85–106.
- Lycan, W.G., 1990, "What is the 'Subjectivity' of the Mental?", *Philosophical Perspectives* 4, Tomberlin, J. (ed.), *Action Theory and the Philosophy of Mind*, 109-130
- Lorenz, K., 1975, "Kant's doctrine of the a priori in the light of contemporary biology". In Evans, R. (ed.), *Konrad Lorenz: The man and his ideas*, New York: Harcourt Brace Jovanovich, 181-217.
- McKie, D., 1944, "Wöhler's 'Synthetic' Urea and the Rejection of Vitalism: a Chemical Legend", *Nature*, 153: 608-610.
- Machamer, P., Darden, L., Craver, C., 2000, "Thinking about mechanisms", *Philosophy of Science*, 67: 1-25.
- Merchant, C., 1980, *The Death of Nature: Women, Ecology, and the Scientific Revolution*, San Francisco: Harper and Row.
- Merleau-Ponty, M., 1962, *Phenomenology of Perception*, trans. C. Smith, London: Routledge Kegan Paul.
- Mossio, M., Moreno, A., 2010, "Organisational closure in biological organisms", *History and Philosophy of the Life Sciences*, special issue on *The Concept of Organism: Historical, Philosophical, Scientific Perspectives*, Huneman, P., Wolfe, C.T. (eds.), 32(2-3): pp.

- Nietzsche, F., 1882/2001, *The Gay Science*, ed. B. Williams, trans. J. Nauckhoff, Cambridge: Cambridge University Press.
- Nuño de la Rosa, L., 2010, “Becoming organisms. The organisation of development and the development of organisation”, *History and Philosophy of the Life Sciences*, special issue on *The Concept of Organism: Historical, Philosophical, Scientific Perspectives*, Huneman, P., Wolfe, C.T. (eds.), 32(2-3): pp.
- Oyama, S., 2000, *The ontogeny of information: Developmental systems and evolution*, 2nd revised edition, Durham: Duke University Press.
- Oyama, S., 2010, “Biologists behaving badly: Vitalism and the language of language”, *History and Philosophy of the Life Sciences*, special issue on *The Concept of Organism: Historical, Philosophical, Scientific Perspectives*, Huneman, P., Wolfe, C.T. (eds.), 32(2-3): pp.
- Phillips, D.C., 1976, *Holistic Thought in Social Science*, Stanford: Stanford University Press.
- Pradeu, T., 2010, “What is an organism? An immunological answer”, *History and Philosophy of the Life Sciences*, special issue on *The Concept of Organism: Historical, Philosophical, Scientific Perspectives*, Huneman, P., Wolfe, C.T. (eds.), 32(2-3): pp.
- Putnam, H., 1975, “Philosophy and our mental life”. In *Mind, Language, and Reality. Philosophical Papers*, vol. 2, Cambridge: Cambridge University Press, 291-303.
- Ratcliffe, M., 2001. “A Kantian Stance on the Intentional Stance”, *Biology and Philosophy*, 16: 29-52.
- Richards, R.J., 2002, *The Romantic Conception of Life: Science and Philosophy in the Age of Goethe*, Chicago: University of Chicago Press.
- Rosen, R., 1985, “Organisms as causal systems which are not mechanisms”. In Rosen (ed.), *Theoretical biology and complexity*, Orlando: Academic Press, 165-203.
- Rosen, R., 1991, *Life Itself: A Comprehensive Inquiry into the Nature, Origin and Fabrication of Life*, New York: Columbia University Press.
- Ruiz-Mirazo, K., Etxeberria, A., Moreno A., Ibáñez J., 2000, “Organisms and their place in biology”, *Theory Bioscience*, 119: 209-233
- Ruiz-Mirazo K., Moreno A., 2004, “Basic autonomy as a fundamental step in the synthesis of life”, *Artificial Life*, 10(3): 235-259

- Ruyer, R., 1930, *Esquisse d'une philosophie de la structure*, Paris: Alcan.
- Ruyer, R., 1952, *Néo-finalisme*, Paris: PUF.
- Salomon-Bayet, C., 1978, *L'institution de la science et l'expérience du vivant: méthode et expérience à l'Académie Royale des Sciences, 1666-1793*, Paris: Flammarion.
- Schelling, F.W.J., 1803/1988, *Ideas for a Philosophy of Nature*, trans. E.E. Harris & P. Heath, Cambridge: Cambridge University Press.
- Schiller J., 1978, *La notion d'organisation dans l'histoire de la biologie*, Paris, Maloine.
- Schlanger, J., 1971, *Les métaphores de l'organisme*, Paris: Vrin.
- Schlick, M., 1953, "Philosophy of organic life". In Feigl H. & Brodbeck, M. (eds.), *Readings in the Philosophy of Science*, New York: Appleton-Century Crofts, 523-536.
- Simondon, G., 1964, *L'individu et sa genèse physico-biologique*, Paris: PUF.
- Skarda, C., Freeman, W.J., 1987, "How brains make chaos in order to make sense of the world", *Behavioral and Brain Sciences*, 10(2): 161-195.
- Smuts, J.C., 1926, *Holism and evolution*, London: MacMillan.
- Starobinski, J., 1956, *L'idée d'organisme*, Paris: Centre de Documentation Universitaire / Collège philosophique.
- Sterelny, K., Griffiths, P.E., 1999, *Sex and Death: An Introduction to Philosophy of Biology*, Chicago: University of Chicago Press.
- Stotz, K., Griffiths, P.E., Knight, R., 2004, "How biologists conceptualize genes: an empirical study", *Studies in History and Philosophy of Biological and Biomedical Sciences*, 35(4): 647-673.
- Symons, J., 2002, *On Dennett*, Belmont: Wadsworth Academic.
- Symons, J., 2010, "The individuality of artifacts and organisms", *History and Philosophy of the Life Sciences*, special issue on *The Concept of Organism: Historical, Philosophical, Scientific Perspectives*, Huneman, P., Wolfe, C.T. (eds.), 32(2-3): pp.
- Thomson, A., 1988, "L'Homme-machine, mythe ou métaphore?", *Dix-huitième siècle*, 20: 367-376.
- Thomson, W., 1884, *Lectures on Molecular Dynamics and the Wave-Theory of Light*, Baltimore: Johns Hopkins University Press.

- Turner J.S., 2000, *The Extended Organism: The Physiology of Animal-built Structures*, Cambridge, Mass.: Harvard University Press.
- Varela, F.J., 1979, *Principles of Biological Autonomy*, New York: Elsevier North Holland.
- Varela, F.J., Maturana, H., 1972, "Mechanism and Biological Explanation", *Philosophy of Science*, 39(3): 378-382
- Varela F.J., Shear J., 1999, "First-person methodologies: why, when and how", *Journal of Consciousness Studies* 6(2-3): 1-14
- Walsh, D., 2010, "Two Neo-Darwinisms", *History and Philosophy of the Life Sciences*, special issue on *The Concept of Organism: Historical, Philosophical, Scientific Perspectives*, Huneman, P., Wolfe, C.T. (eds.), 32(2-3): pp.
- Weber, A., Varela, F.J., 2002, "Life after Kant: Natural purposes and the autopoietic foundations of biological individuality", *Phenomenology and the Cognitive Sciences*, 1: 97-125.
- Weiss, P., 1967, "1+1≠2 (When One Plus One Does Not Equal Two)". In Quarton, G.C., Melnechuk, T., Schmitt, F.O. (eds.), *The Neurosciences: A Study Program*, New York: Rockefeller University Press, 801-821.
- Wilson, J., 2006, "On Characterizing the Physical", *Philosophical Studies*, 131:61-99.
- Wilson, R.A., 2007, "The Biological Notion of Individual", *The Stanford Encyclopedia of Philosophy* (Fall 2008 Edition), URL = <http://plato.stanford.edu/archives/fall2008/entries/biology-individual/>
- Wolfe, C.T., 2004, "La catégorie d' 'organisme' dans la philosophie de la biologie. Retour sur les dangers du réductionnisme", *Multitudes* 16: 27-40 — also online at http://multitudes.samizdat.net/article.php?id_article=1370
- Wolfe, C.T., 2006, "L'organisme, une fiction instrumentale?", *Sciences et Avenir Hors-Série : La fiction scientifique*, 147: 41.
- Wolfe, C.T., 2009, "Organisation ou organisme? L'individuation organique selon le vitalisme montpelliérain", invited article for special issue of *Dix-huitième siècle* 41: 95-115.
- Wolfe, C.T., forthcoming 2010a, "Why was there no controversy over Life in the Scientific Revolution?". In Boantza, V., Dascal, M. (eds.), *Controversies in the Scientific Revolution*, Amsterdam: John Benjamins.

Wolfe, C.T., forthcoming 2010b, “Le mécanique face au vivant”. In Roukhomovsky, B., Roux, S. (dir.) *L'automate : modèle, machine, merveille*. Bordeaux, Presses universitaires de Bordeaux ; draft online at <http://www.scribd.com/doc/27716867/Cw-Automates-epreuves-2009>

Wolfe, C.T., 2009 (ms.), “The Return of Vitalism: Canguilhem and French Biophilosophy in the 1960s”

Wolfe, C.T. (ed.), 2005, *Monsters and Philosophy*. London: King’s College Publications.

Wolfe, C.T., Terada, M., 2008, “The 'animal economy' as object and program in Montpellier vitalism”, *Science in Context*, special issue on Medical Vitalism in the Enlightenment, C.T. Wolfe (ed.), 21(4): 537-579.

Wouters, A., 2005, “The functional perspective in evolutionary biology”. In Reydon, T., Hemerik, L. (eds.), *Current Themes in Theoretical Biology*, Dordrecht: Springer, 33-69.