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Life after Kant: Natural purposes and the autopoietic foundations of biological individuality

ANDREAS WEBER AND FRANCISCO J. VARELA (1946–2001)
Humboldt-Universität zu Berlin, Kulturwissenschaftliches Seminar, Sophienstraße 22a, 10178 Berlin, Germany (E-mail: andreas.weber@rz.hu-berlin.de)

Abstract. This paper proposes a basic revision of the understanding of teleology in biological sciences. Since Kant, it has become customary to view purposiveness in organisms as a bias added by the observer; the recent notion of teleonomy expresses well this "as-if" character of natural purposes. In recent developments in science, however, notions such as self-organization (or complex systems) and the autopoiesis viewpoint, have displaced emergence and circular self-production as central features of life. Contrary to an often superficial reading, Kant gives a multi-faceted account of the living, and anticipates this modern reading of the organism, even introducing the term "self-organization" for the first time. Our re-reading of Kant in this light is strengthened by a group of philosophers of biology, with Hans Jonas as the central figure, who put back on center stage an organism-centered view of the living, an autonomous center of concern capable of providing an interior perspective. Thus, what is present *in nuce* in Kant, finds a convergent development from this current of philosophy of biology and the scientific ideas around autopoeisis, two independent but parallel developments culminating in the 1970s. Instead of viewing meaning or value as artifacts or illusions, both agree on a new understanding of a form of *immanent teleology* as truly biological features, inevitably intertwined with the self-establishment of an identity which is the living process.

A clash of doctrines is not a disaster, it is an opportunity.

A.N. Whitehead

1. Introduction

1.1. *The Kantian heritage*

This article is an immodest reformulation of a central issue in the philosophy of biology: the topic of natural purposes or teleology. The motivation for this attempt is that we perceive a great need to bring to the fore a remarkable and recent convergence between the re-awakening of the philosophical discussion concerning natural purposes (with Hans Jonas as the central figure), and an independent but convergent stream of thought concerning biological individu-

ality and the organism (with the autopoiesis school as the central figure).[1] These two streams reinforce and extend each other to such an extent that we boldly advance the conclusion that, after two centuries, we can move *beyond* the unstable position set out by Kant in the *Critique of Judgement*, and therefore provide a fresh re-understanding of natural purpose and living individuality.

It has become a common place in modern biology to shun teleological thinking or to reduce it to mere methodological fiction, then called teleonomy (Pittendrigh 1958). The overwhelming preference is to explain biological facts as the statistical results of natural selection which *post factum* give the semblance of goal-directedness (Dawkins 1987). Purpose-directed structures or events are only allowed in an "as-if" mode; a teleological explanation can always be substituted by a (teleonomic) factual description (Nagel 1977). Nevertheless, talk about purpose or function, even though regarded as "as if" descriptions, is pervasive and persistent in Biology. The least that one can say is that there is a certain paradoxality concerning the role of teleology in biological matters – a paradoxality, whose solution is central to the understanding of biological science. In spite of being shunned, "Nature's purposes is arguably the most important foundational issue in the philosophy of biology" (Allen et al. 1998, p. 2). The answer to the question of what status teleology should have in biology decides about the character of our whole theory of animate nature.

The subject has, of course, a long history. The Greeks experienced nature as an ever-present horizon, most clearly set in Aristotle's dictum: the final cause is a necessary precondition for the mechanical cause. But in medieval times the idea of finality radically shifted to divine will and design, the source of all meaning and purpose. The enlightenment opposed to that the even more radical position of human mind as the measure of things, where nature is only seen as mere object for the human subject. Recent times have shifted to post-modern views on nature as a purely historical locus, contingent and relative. However, as we will argue in this paper, in sharp contrast to such views, there is a live current in modern thinking that advances a re-discovery of teleological thinking, aligning with the marginal but steady need for many biologists to take teleology seriously, that is persistent from the XIXth century on up to the present.[2]

Now, any discussion about teleology in science and western thinking altogether is inescapably grounded on the prodigious basis provided by Immanuel Kant. The fundamental twist in Kant's analysis is to postulate that the laws governing organic reality were a bias added by the limitation of our intellect. He insisted that

> the innate reasoning categories of mechanistic causality that humans appropriately bring to their analysis of *nonliving* reality were incapable of doing justice to the activities of the living realm. To make sense of life as a phenomenon, human judgement was forced to postulate . . . an additional principle of teleological causality. (Harrington 1996, p. 5).

For Kant, the organism could not be understood in purely mechanistic terms. But this did not imply that it would definitely not work in those terms: Kant thought that a *judgement* was simply not possible for the human mind (Plessner 1982). It is this latter point that still provokes a misunderstanding by many readers: Kant neither ruled out mechanism, nor did he declare it to be "the real reality" beneath the phenomena. He was only completely pessimistic about the possibility that organic life could be explained in purely mechanistic terms – and hence did not believe in the possibility that once "a Newton of the Grassblade" could deliver a reductionist *and* complete account of the organic world (Cornell 1986, p. 408). Kant thus makes

> . . . both the mechanical and teleological principles with respect to organism mere maxims of inquiry of comparable, but not total, explanatory power. We simply do not know what, if anything, is "behind" life, "causing" its basic purposive quality in some ultimate sense (Plessner 1982, p. 247).[3]

In brief, Kant introduced an unstable middle position which is a central concern of this paper as an attempt for resolution. Being an adherent to Newton-style physics, he nonetheless reserved for the organism another kind of thinking: the living was to be conceived in terms of *natural* purposes. This notion explicitly touches the self-organizing properties of living matter: it can be argued that Kant himself introduced the term "self-organization" in its modern sense into biological theory. Nonetheless the received view (in Neo-Kantism, but especially also in the Anglo-Saxon philosophical tradition) is a strong reductionism that allowed discourse about organisms "as if" they behave teleologically, but sees them in reality as strictly mechanistic. It is this reading that has been most influential today, which enthrones Kant as a father of reductionist biology. In this paper we will argue, along with a number of modern writers, that Kant in his *Critique of Judgement* (referred to as KdU hereinafter) developed the possibility of a third way between a strong teleology and a brute materialism. Our main contribution here is to advance a resolution of this unstable position into a fully mature re-understanding on the basis of modern developments of biological research and thinking, to which we now will turn.

1.2. *Teleology and organism in current biology*

The term teleology has remained quite ambiguous in biological science since Kant's time, and has become even more so after Darwin. Many current problems stem from a mixing up of two main understandings of the term. Broadly, we can discern an *external* seemingly purposeful design, which was Darwin's main concern (Lennox 1993), and which he conceptualized as the result of contingency and natural selection (Löw 1980; Zumbach 1984).[4] *Intrinsic* teleology on the contrary is concerned with the (Aristotelian) internal purposes immanent to the living which was *Kant's* main concern (Ayala 1970). It is also that kind of purposefulness and goal-directness that can account for everybody's naive intuition: we strive to go on, to develop, to keep ourselves in a dynamical balance (Spaemann and Löw 1981). For Aristotle, the *ego ago propter finem*, the structure of one's own movement according to a *telos*, can be understood from the paradigmatic case of the organism. Because of this original nature, the experienced telos is the paradigm of an immediate experience as such. For Aristotle, the causal, mechanical world is an abstraction drawn from the most important *causa finalis* (Löw 1980).

In our present scientific world, following a received and narrow interpretation of Kant, it is just the opposite: the teleological behavior of living beings is an illusion, an appearance hiding the underlying mechanism. In current biology, the situation is quite ambivalent: On the one hand for many biologists any notion of teleology appears as in blunt opposition to the central dogma of Darwinism. On the other hand, recent work has developed an account for biological form and the living in terms of self-organization and morphological laws in frank opposition to the adaptationist program.[5] Here we will be concerned with the paradigm of self-organization of the living as autopoiesis which is part and parcel of modern criticism of the strictly adaptationist tradition wherein there cannot be any place for teleology except in its teleonomic sense. In the following we will exploit this tension within modern biology to surmount the main difficulties concerning the role of teleological explanations in biology.

The role of teleology not only has to be evaluated anew because of the obviously persistent practice in biology to invoke teleological explanations while at the same time denying their consequences. Hidden in this lack of clarity lie central philosophical problems of biology that have shown to be hardly solvable in the still dominant style of anti-teleological, neo-Darwinist conceptions. In spite of all technical success of reductionist biological thinking the central question of biology remains an open problem (Mathews 1992),

and reductionist accounts are still unable to define in precise terms the living process" (Kull 1999).

This situation stems from the systematic tendency to marginalize the real, living individual which includes organisms such as the *lived* body (a *Leib*, not only a *Körper*), as a unitary locus capable of experience. In other words, if there is any systematic absence in the thinking about modern biology, it is a fully developed notion of an *organism*, instead of a an array of genetic and physiological processes whose unity is left unaccounted for: "The organism as a real entity, existing in its own right, has virtually no place in contemporary biological theory" (Webster and Goodwin 1982, p. 16). This absence has been underlined for decades from several sides. Especially under attack have been the current paradigm's naive genetic objectivism, its inability to account for many problems of development, but also its failure to explain phenomena of biological diversity, inventing *ad hoc* hypotheses instead. The intention of this paper is not to address these broad issues in their complexity; the few points provided above will have to suffice.[6]

We will argue that without paying full attention to organismic complexity, which includes the organism in its most basic lived dimensions, modern biology is bound to miss central insights for understanding life, and it will suffer from the resulting paradoxes (Bedau 1996). (For instance in "defining" life by an encyclopedic listing of qualities living systems usually have). As Spaemann and Löw (1981, p. 139) observe, the challenge that the living organism presents to the rational interest in a unity of nature and experience is seen by many authors as a kind of scandal that needs to be banished. One of its most flagrant manifestations is the way this echoes into the current debates concerning the mind-body problem, yet another important dimension that will not concern us here.[7]

In contrast to Kant we are no longer dependent only on speculations concerning self-organization in nature. These recent advances, however, have been mostly ignored by those philosophers who have revived the question of teleology. In the following we want to re-take from an empirical standpoint the arguments Kant had pursued to explain natural purposes. We will propose a reading of Kant's notion of teleology that explicitly rejects a narrow interpretation based on the *Critique of Pure Reason*. Rather, we will argue for an "intrinsic teleology" arising from biological autonomy and biological individuality (Varela 1979).

This line of argument, we have said, dovetails with an organismic philosophy, most remarkably developed by Hans Jonas at about the same time. Jonas proposed a "pre-autopoietic" concept of organism already in the early 1950s

and in an astonishing way precedes and philosophically extends the findings of autopoiesis. Jonas, in speaking of "necessity" and "freedom" as the basic features (and paradoxes) of organic life in its minimal form, offers a reading of the problem of causality and teleology that can contribute much to the crucial question in how far the organism is the creator of a "real teleology" – a notion implied in the concept of autopoiesis. And because autopoiesis is an empirical theory of life, the minimal organism thus provides the door – contra Kant – to a non-reductive yet "hard" explanation of the living. Both lines of argument lead to the conclusions that a notion of *intrinsic teleology* is possible.

Thus, our way of naturalizing teleology will be just the opposite of the classical reductionist approach made by certain authors, who attempt to solve the problem by transforming teleological statements in a simple "naturalistic" description (Nagel 1977; see Bedau 1992 for criticism). We think, in contrast, that an integration of teleological descriptions can only be possible by taking them seriously: by accepting that *organisms are subjects having purposes according to values encountered in the making of their living*. This means clearly to reintroduce value and subjectivity as indispensable organic phenomena, a theory of the organism as the dynamics of establishing an identity and, hence, as a process of creating a materially embodied, individual perspective.

1.3. *Outline of the paper*

This introduction has laid out the basis on which we can now examine its parts in further detail. The paper unfolds in three main sections:

In Part II we recapitulate in some detail the principal thesis in "the most neglected sector of Kant's Critical Philosophy [that] is his collection of remarks about biological phenomena in the second part of the *Critique of Judgement*, the Critique of Teleological Judgement" (Zumbach 1984). We emphasize the many ways in which the text has strong non-reductionist tendencies which were the basis for a continuous stream in German philosophy of biology, where it inspired partly romantic natural philosophy (Löw 1980), and also contributed greatly to the program of organismic biology (the so-called German school of teleomechanism) with towering protagonists such as Johannes Müller and Karl Ernst von Baer (Lenoir 1982).

In Part III we take up the challenges left open by Kant and project them into two concurrent trends in modern thinking developed independently, roughly in the period 1950–1970. On the one hand, we focus on a cluster of mostly German thinkers leading to a revival of the philosophy of nature and

of the question of teleology as its central knot. Although multiple, we delve mostly on the work of Hans Jonas as the most emblematic and profound. On the other hand, we focus on a school thought about the living as a process of establishing an identity based on biological research rather than philosophy, with the emblematic notion of autopoiesis as the characterization of the living. (See References for a full bibliography of these two trends).

Part IV draws the inevitable conclusion that there is enough progress in our understanding between Kant's time and the recent trends in science to advance a way out of the unstable aporias identified by Kant, and that a renewed view of what can be called *intrinsic teleology* can be defended.

2. Kant between "transcendental agnosticism" and irreducible teleology

2.1. *The context for Kant's critique of teleological judgment*

Kant's stance on some essential issues, as is well known, is multifaceted and often ambivalent, and may depend on the chosen quotations (Löw 1980). This is partly why there have been a corresponding multiplicity of interpretations of his work, giving rise to schools. In Germany, for instance, Kant has been explicitly claimed as philosophical root by both the German romantic *Naturphilosophie* and the strictly physicalist program of Helmholtz and others (Spaemann and Löw 1981). So ironically Kant has provided inspiration to conceptual opposites in order to accomplish what Kant himself had thought to be an impossible task: to give an objective account of the organic world. Of these competing interpretations of the Kantian heritage it is the reductionist-leaning reading that has been most influential in the Anglo-Saxon world (Löw 1980).

Indeed, Kant himself was very focused on how the transcendental subject and the world are related. He attempted a number of approaches and thus a movement is clearly visible in the course of his writings that partly accounts as the source of his ambivalence. Therefore it is necessary to view the Kantian philosophy not as a hieratic monument but rather as a work in progress, starting from the *Theorie des Himmels* as a first major work, and ending with his remarks in the *Opus Posthumum*. As is apparent in the unfinished building blocks of this last work, Kant's struggle is centered around an ever more deepening of the question how external apperception is possible in a thinking subject, starting from the pure scientific experience of his pre-critical phase and the *Kritik der reinen Vernunft*, then moving on to aesthetic experience and with

that, arriving at the analysis of the organic world. Because man as a thinking subject is also a reality of the external world, hence part of nature, the critical work had not been exhausted with the first two critiques.

Now, in his initial phases, nature for Kant was an objective system of physico-mathematical relationships construed by the subjectively necessary apperception of space and time and the categories of pure reason. It is the structure of reason that forces experience to be of a Newtonian kind of world. There are no subjects apart from the transcendental unity of self-consciousness – the "I think that must be able to accompany all my representations" (KrV, B, p. 132).[8] Hence there are no embodied living beings in any irreducible sense. Kant admits that a breaking down of organic entities to their underlying inorganic basic components is certainly possible, and even if not yet accessible, should be attempted (KrV, B, p. 555).

It was Kant's conviction, then, that all processes in nature could be explained in terms of mechanical causality. Final phenomena, on the contrary, only could be viewed as processes taking place in the interpreting human consciousness and hence could be dismissed from a true picture of nature (Löw 1980, p. 285) – for many this view is still valid today (see, e.g., Grünewald 1996). A science of nature could only be called so "if the laws of nature that are its base are known (*erkannt*) *apriori* and are not just laws of experience" (*Akad.-A*. IV, p. 468). The corresponding idea of an objective nature thus is a system of purely mathematical relationships. Biology therefore, as a science, is only valid insofar as it is reducible to strictly causal laws.

But this reductionism, as Kant already knew, had a weak point: Not everything could be so neatly subsumed under the apriori principles of pure reason. This fact apparently bothered Kant more than many of his followers, who would stop within the theoretical frame of the *Critique of Pure Reason*. But for Kant himself it was especially the empirical and not apriori character of biology that posed a grave problem, because "its first principles must ultimately be found in experience. It must assume that certain bodies are organized and the particular form of their organization must be taken as given in experience" (Lenoir 1982, p. 29).

In fact, Kant had to fight on two fronts: he was defending his view against *l'homme machine* as well as against the teleology of the Wolffians (Löw 1980, p. 126). This hesitating on an intermediate position is already visible in his early critical phase: Since for making possible causal explanations inside the world, Kant, as a frame of his idea, had to postulate the whole world as an idea of pure reason. Kant had to anchor causality in a purely intelligible world of mathematical relationships. He had to found his supposition about causality in a theory of the world as a whole. Concerning biology, this can no longer

be overseen: In organisms the faculty of judgement is confronted with a host of such "wholes", so that the "integrating force of the idea of the world returns in the idea of purpose on a regional level in the *Critique of Judgement*" (Spaemann and Löw 1981, p. 134).

2.2. *Self-organization and intrinsic teleology*

The problem is that the empirical manifold of organic nature apparently cannot be founded on *a priori* knowledge.[9] Because the faculty of reason is only able to construct theories in the a priori mode, biology cannot be constructed, it must necessarily transcend the sole capacity of reason:

> According to the position developed by Kant in the *Kritik der Urteilskraft*, therefore, biology as a science must have a completely different character from physics. Biology must always be an empirical science. Its first principles must ultimately be found in experience. (Lenoir 1982, p. 26 passim)

This is consistent with the idea that there are "concepts embedded in our biological conceptual scheme – concepts of design – which cannot be constructed from the conceptual resources of physics" (Zumbach 1984. p. 89). To deal with this empirical manifold Kant analyzed a faculty of reason that up to this point he had not paid so much attention to: the faculty of judgement.

To reconcile the faculty of judgement with the laws of nature given apriori, Kant was moved to introduce an *ad hoc* correspondence of world and reason by "happy chance" (KdU, Introduction, 184) to guarantee the fitting of empirical experience and categories of reason. To keep the coherence of his transcendental system, this chance correspondence was nonetheless given the status of an apriori principle (*Akad.-A*. XX, p. 210). The one commanding feature of this faculty of judgement concerning nature was that it viewed nature as *teleological*. As an apriori principle nature has to be thought *as if* it is made with the aspect of purpose.[10]

Now there are several levels on which finality can be seen. Living nature can be viewed under the aspect of "objective, material, outward purposiveness", that is, "relative finality", or as "objective, material, inward", that is, "absolute purposiveness." The former deals with the theological question of useful relations of natural things to one another as they have been made by God, e.g., questions of the sort if rivers have been created to serve man for navigation. Kant massively rejects explanations current at that time based on relative purposiveness: This is to interpret natural objects simply as means – and to do that would only be possible if the goal these means are serving for had the

character of an objective purpose of nature, a notion strictly refuted by Kant's transcendental approach (Spaemann and Löw 1981).

So Kant's interest concerning teleological explanations touches *intrinsic*, and not relative purposiveness. This conception is not without a certain resonance with an Aristotelian tradition. Nonetheless, it was Kant who elaborated for the first time the similarity of this *intrinsic teleology with a modern understanding of self-organization*. For Kant things that organize themselves are – in opposition to purposes of nature – called *natural purposes*. These are the organisms where the Kantian notion of intrinsic teleology has its original place. Two issues are closely related here: First, the organism's structure is contingent in the highest degree; we cannot understand the necessity of their existence by a priori principles. Second, they are nonetheless related to a principle of reason – and this principle now is their teleological understanding. Natural purposes – organisms – are goal-directed in the following sense: "A thing exists as a natural purpose *if it is* (though in a double sense) *both cause and effect of itself*" (KdU § 64, 370, Kant's emphasis). This interrelation of means and goals describes a circular situation: parts of an organism are there through the existence of the whole and the whole is responsible for the parts. But not only this: there is also a processual, dynamical aspect already implicit, when Kant says:

> In such a product of nature every part, as existing through all other parts, is also thought as existing for the sake of the others and that of the whole, i.e. as a tool (organ); . . . an organ bringing forth the other parts (and hence everyone bringing forth one another). . .; and only then and because of this such a product as an *organized* and *self-organizing* being can be called a *natural purpose*. (KdU § 65, 373, Kant's emphasis).

Because of this self-organizing circularity, which will be our leading thread in its relation to the autopoietic interpretation of the living in what follows, all relations of cause and effect are also relations of means and purpose. Being a natural purpose then, as an interrelated totality of means and goals, is strictly intrinsic to the organism – it is in fact the only way we can view it, and by the way, just the way we normally, *prima facie* and intuitively, view the living.

Thus what is important for Kant exceeds by far what Zumbach (1984, p. 129) means, when he writes:

> Biology is autonomous because we *explain* the presence and arrangement of biological parts in functional terms. This introduces a mode of explanation into biology which is generally reserved for explaining the features of artifacts.

This is less the character of Kant's position than it is that which is meant today by teleonomy. How organisms work is just *not* the way artifacts work:

the latter always point to an external purpose they are made or used for, the former *are* purposes with the goal of keeping existent by organizing themselves. We will soon see how far this distinction between artifact and organism as a principle of reason can be substituted by a material one in the work of Jonas.

2.3. *Causality and teleology*

Kant's way to look at organisms, however, is also transcendental: the teleology we observe in natural purposes is not necessarily the mode in which they really exist but merely our way to view them. Contrarily to the teleonomy interpretation (regard organisms as goal-oriented as a heuristic until we find the adequate causal explanation), Kant leaves no doubt in KdU that our human minds must necessarily explain organisms in teleologic terms; we are intrinsically limited (see Merleau-Ponty 1994, p. 45). This is the case because in the empirical domain we must use the faculty of reflective judgement that searches, for each particular, the general law (or maxim) under which it is subsumed (KdU, § 69, 385). Kant postulates that

> certain products of nature, according to the particular structure of our reason, *must* be *viewed by us* as created deliberate and with purpose; without demanding, though, that there really be a particular cause that has the idea of a purpose to its defining ground. . . (KdU § 77, 405/6; Kant's emphasis).

So now, what is the relationship between finality and causality in Kant? Obviously, in biology, organisms should be explained in mechanical terms as long as this does work; only after that fails should one invoke teleology. Thus there is a competition between the principle of causality and the maxim of reflective teleology: For Kant teleological and causal statements are two *kinds* of judgments about things, always concerning the thing-as-such, approached in two different ways without being finally exhausted. This is what is called the Kantian *teleomechanism*, giving birth to a whole school of German biological research (Lenoir 1982, p. 12).

To insist: Kant's position is more radical than Zumbach (1984, p. 107) wants us to believe when he writes: "His explanatory anti-reductionism is the position that all events are mechanical (or physical), however, biological phenomena are not "explicable" in purely mechanistic terms." Zumbach (1984, p. 129) views Kant's organismic position mainly as an epistemological claim: Kant rejects purely mechanist thinking not for its objective principles but because of our own a priori constitution (Zumbach 1984, p. 82). Thus Kant appears to

act as an anti-reductionist and as an anti-vitalist at once: he is an ontological reductionist, but an epistemological anti-reductionist – or, as Löw (1980, p. 163) has it, a "transcendental agnosticist."

But at the same time Kant leaves no doubt about the priority of teleology over causality: In the end, concerning the living, teleology wins over mechanism. Even if it is reasonable, nay, full of merit, to try to explain teleological features in terms of cause and effect, we have to be aware of the "necessary subordination of the principle of mechanism under the principle of teleology" (KdU § 80, 417). Certain products of nature *force* us to reflect on an end that is not given to us, and this seems to be a hint that the principle of purpose pertains to the things themselves (Spaemann and Löw 1981, p. 137).

The problem of the relationship between causality and teleology is, in fact, a masked attempt to solve the question of how inner experience is to reconcile with an external world; hence, it is a direct reaction to the mind-body problem.[11] This also is why teleology is rapidly dismissed from modern biology by the same reasons by which the lived body is neglected. For Kant, however, its final solution in the *Critique of Judgement* lies in the admission that our mind as an *intellectus ectypus* working with discursive reason is not able to see far enough so that he must rely on two entirely different principles to describe physical reality in its organic forms (KdU § 77, 407 passim). Only an *intellectus archetypus* knowing the world intuitively and not discursively could theoretically reconcile the two maxims, but man as a knowing subject is restricted to the former.

The question of whether a teleological understanding unveils things as such or only shows the situation of an observer overlaying an idea over some structures that are not farther accessible has also been an inspiration for Goethe's biological works. Actually, Schiller understood his account of the *Urphänomen* in a Kantian way, whereas Goethe claimed to reach farther with the intuiting sight of the poet-naturalist (Böhme and Böhme 1983. p. 110).

The problem (that organic systems can be understood as inorganic ones plus human interpretation) resurfaces in some forms taken by a modern reformulation concerning self-organization: Is it a self-organizing systems that exhibits ontologically these features, or does the observer add his perspective to an otherwise completely neutral behavior? Contemporary debate is more inclined to reject this attitude and assume an ontological validity for the manifestations of complexity.

For Kant this question is never decided in a definitive manner. Hence for him it was impossible that a new Newton of Biology could arise, impossible to account even for a "blade of grass" without the principle of purposiveness (KdU § 75, 400; also see Cornell 1986, p. 405). Charles Darwin has often been

claimed to be this new Newton of the grass blade, and thus to invalidate Kant's famous dictum. In a way this is not false: the theory of evolution is Newtonian in its character and does attempt to account for design. But, in the end, it seems that Kant had been right in denying a Newtonian, mechanical character of the living: Evolutionary thinking had to re-discover the autonomy and self-organization of the organism and their importance for evolution, so that the Newtonian dominance consequently could be trimmed down considerably, making place for the organism's creativity.[12]

This puts us squarely on the trail of the next section, re-phrasing how this Kantian heritage may be extended in two major ways today. First, we can rely on the important progress about self-organization that has been made since, coming close to a causal explanation, but introducing a new mode of analysis that includes the minimal form of living as an autopoietic process. Second, we can extend the range of human understanding as an embodied being by the fuller investigation of the lived body in a phenomenological sense through post-Kantian developments in phenomenology especially in Jonas. These two points combined give us the depth to *naturalize teleology*. Only these two points together provide us with the means to move beyond and improve on Kant's monumental work. In a way this will also signal a resonance with the Aristotelian tradition, that we can understand natural beings because we are also a natural being.

3. The self-production of subjectivity

3.1. *Jonas' phenomenological inversion*

Kant himself had already hinted that he realized his thinking was incomplete in important ways (XII, 254 passim), which corresponds to our interpretation of the direction Kant was aiming at in the *Critique of Judgement*. This is strongly visible in his last philosophical writings, the *Opus Posthumum*, where he inverts the work undertaken in the *Critique of Pure Reason*. Without invalidating the apriori categories that had been the possibility of all knowledge, Kant finds an entirely new foundation for them: the lived body. The moving forces of matter – prime subject of natural science – are not deduced from or "dictated" by the apriori categories of reason but themselves are a basic *experience* underlying all apriori categories:

> The moving forces of matter are what the moving subject himself does with his body on other bodies. – The counter-effects corresponding to theses forces are contained in the simple acts by which we perceive the bodies themselves (*Akad.-A*. XXII, p. 326).

Hence the *apriori* categories are an experience of an embodied existence. From this viewpoint the body has taken the place of the apriori of all experience:

> Only thereby is the subject [aware of his] moving forces able to act and . . . of their counter effect, whose relation is known *apriori* . . . the counteracting moving forces of matter are anticipated and the qualities of matter are fixed. (*Akad.-A*. XXII, p. 506).

With this argument Kant has given teleology an apriori foundation in the subject experiencing itself purposefully as itself and also as connected to the world (Spaemann and Löw 1981, p. 140).

This is very close to the way Jonas criticizes the Kant of the critical period, and it is also the starting point of Jonas' own organic philosophy. For Jonas

> the living body is the archetype of the concrete, and, in so far as it is my body, it is, in its immediacy of interior and exterior perspectives in one, the only fully given concretum of experience at all. (Jonas 1973, p. 39)

It is actually by experience of *our* teleology – our wish to exist further on as a subject, not our imputation of purposes on objects – that teleology becomes a real rather than an intellectual principle. Thus causality, as it is perceived by us as sentient beings, may be subsumed under the more general *principle of life*. And if teleology is the way organisms are working, and if the categories of apperception are defined by the way an organism works, then the category of causality follows from the teleology of the living rather than vice versa:

> Causality is not so much an apriori foundation of experience but rather it is itself a basic experience. It is known by the effort I have to make in coping with the resistance of world-matter during my activity and in resisting the pressure of this world-matter. (Jonas 1973, p. 38).

Kant's philosophy of the living was a philosophy about a scientific theory of organism. Jonas turns this on its head in a quintessential phenomenological style: before being scientists we are first living beings, and as such we have the evidence of our intrinsic teleology in us. And, in observing other creatures struggling to continue their existence – starting from simple bacteria that actively swim away from a chemical repellent – we can, by our own evidence, understand teleology as the governing force of the realm of the living. Theories about the living can only be conceived from the fragile and concerned perspective of the living itself: ". . .life can only be known by life" (Jonas 1973, p. 91).[13]

This inversion of terms is full of consequences as it traces directly into the human existential level as part of life, as well as in the presence of death. The movement that defines an intrinsic goal is given in our daily experience as the "Yes!" to our continued existence being the mother-value of all values. Our experience of ourselves *is* actually embodied, and refusing this argument logically ends up in leaving aside the pregnancy of being a living being for oneself. The argument parallels the central figure of Apel's "transcendental pragmatics" as well as the ethic of Habermas, on an embodied level. Our teleological reality cannot be denied without equally denying our own status as sentient beings who have a right to the pursuit of an undisturbed life. As Spaemann and Löw (1981, p. 281) write: "the access to the problem of teleology is always one's own experience of acting, viz. the experience of desire and drive."[14]

Thus, it is not our own constitution as a subject of reason – as Kant saw it for most of his life – that grounds the pathways of analytical and synthetical judgments and consequently determines which object domain we must perceive as teleological. Rather, the very ground of our existence is originally teleological and as such, in the ongoing coupling with the world brings forth meaning and categories. Teleology thus is not only a necessary mode to think the living; the "teleological circle" is a real mode of being and is the only possible way for organic life to exist. This is what Kant glimpsed near the end of his work.

And this kind of thought, that Apel (1963) has called the "apriori of the lived body" (*Leibapriori*), has taken 150 years to resurface in a new turn in the philosophy of nature around 1960 in contemporary writers such as H. Jonas (taken here as emblematic), A. Portmann, R. Spaemann, and, (following his father Jacob von Uexküll), Th. von Uexküll.[15] The themes we have evoked on the basis of Jonas' writings are surprisingly convergent with these authors, constituting a coherent line of thought in the German world in their renewal of the issue of biological self-hood (or ipseity) (for sources see Reference list B). Each of these authors formulate a similar central point, in different ways however. Jacob von Uexküll understands the living as a "lived world" (where Jonas prefers self-identity). Adolf Portman often uses the notion "interiority" but also self (*Selbst*). Robert Spaeman uses the notion of ipseity (*Selbstsein*). All these formulations are comparable in that they attempt to capture the idea that life and the organism are active agents (and not merely reactive). We will not dwell further on the specific thoughts of these authors, a study that remains to be done (but see Destrée and Dewitte 1996). We may add to these converging ideas those originating from the emerging science of biosemiotics, which takes seriously not only the teleological, but also the crypto-semiotical dis-

course of adaptionism (in speaking of codes and information) by referring to the organism as a subject in its *Umwelt* (Hoffmeyer 1996; Kull 1999; Weber 2001).

3.2. *The re-enchantment of metabolism*

In this context, a central question to examine from an empirical perspective is how an organism can realize its living. Jonas turned to the apparently simple fact of metabolism and elevated it to the core of the organism's ontology. This is where his analysis joins directly with the autopoiesis approach the sources of which are in current biology as an experimental field. In our eyes, this double vision of convergence is what permits us to take a decisive step in giving an account of the organism that is also relevant for human life. There are two essential keys to this turn. First, to put the autonomy of the living at the center, instead of obscuring its role, as has been the case for modern biology (Varela 1997, p. 73). Second, to trace the core properties of the organisms to their *minimal* form. This means a retrospective analysis of biological evolution, back from complex multicellular, vertebrate organisms (such as ourselves) towards the simplest living forms, that is single cells or unicellular organisms.

This second move is crucial because phenomenologists since Merleau-Ponty have repeatedly said that a phenomenological analysis of organisms entails a shift from conceptual categories to the roots of life itself. But this repeated invocation concerning "life" is left unexamined beyond its evocation. Organism is identified with life, and thus with the sphere of perception-action that so predominates the understanding of *Leib*.[16] Jonas is unique in demanding that the analysis be carried to the minimal form of life, to its very origins, and to where it joins the autopoiesis account. It is from this minimal understanding that the qualities of autonomy and purpose can eventually be echoed in the multicellular organism endowed with a nervous system.

For Jonas (1992, p. 21), an organismic "wholeness is self-integrating in active realization, [its] form is not the result but the cause of the dynamic arrangements of matter, and hence the process at the same time *is* the form." By this central aspect of its functioning "metabolism can very well be considered as the defining quality of life: every living being has it, no nonliving being has it" (Jonas 1973, p. 83). As a consequence, we discover the elusive notion of a "constitution of an identity" as the governing of an autonomy principle. Metabolism keeps organisms materially in a steady flux: their substance in no moment is one and the same but at the same time they constantly

keep their identity – and this unchanged identity is kept exactly by the means of an underlying exchange:

> In this strange process of being for an observer the particles of matter that make up the organism in each moment are only temporary and passing contents. Their identity does not converge with the identity of the whole through which they pass. But it is exactly by the passing of alien matter as part of itself that the whole maintains its spatial system, the living form. From a material point of view it is never the same, although it keeps its identity exactly by not keeping the same matter. If it ever will be the same as the sum of its matter it has ceased to live . . . (Jonas 1973, p. 120).

Thus the key distinguishing aspects of the living can be stated as follows:

1. it exchanges its matter and acts thereby from a subject pole partially independent of the underlying matter,
2. as precarious existence it is always menaced by concern (Sorge), the need to avoid perishing, and to do this, it is again completely dependent on matter whose characteristics are the reason for its concern,
3. already the simplest forms of life have thus a subjective perspective as a result of this existential need. Therefore
4. life as such will always be captured in the antinomies of "freedom and necessity, autonomy and dependence, I and world, relatedness and isolation, creation and mortality" (Jonas 1973, p. 3 passim).

At the center of Jonas' description stands the fact that organisms materially create themselves, a notion entirely parallel to the definition of autopoiesis proposed at about the same time Jonas formulated a comprehensive concept of his ideas (in 1973, see below). Matter is not a compound, already structured process. That would still be a Newtonian conception, or an entelechy *sensu* Driesch, or an objectivist structuralism *sensu* D'Arcy Thompson (1966), or, more recently, Goodwin (1982). Matter is also structuring itself in process. In particular, the achievement of metabolism is metabolism itself:

> Our first observation is that Organisms are things whose existence is their own achievement. That means that they only exist because of what they are doing. Therefore the statement, that the existence of organisms is their own achievement simply means: their activity as such is their being. (Jonas 1992, p. 82).

Jonas calls this dialectical priority of form over matter an "ontological surprise." By this expression he means to take the ontological self-producing capacity of chemicals seriously. In other words, the self-realization of the living is an ontological reality *because* it is an empirical reality (in a sense that

we will discuss shortly). Jonas argues against Kant's definitions and in favor of the obvious

> possibility that material systems are units of the manifold (*Einheiten des Mannigfaltigen*) not because of a synthetic apperception (*synthetische Anschauung*) whose object they are, nor because of the pure association of forces that binds their parts together, but by their own power, because of themselves and for themselves." (Jonas 1973, p. 131).

This entails that teleology is a primordial tendency of matter manifest in the form of organisms – hence being in a strong sense "natural purposes."

3.3. *Autopoiesis and self-organization*

For a convincing naturalization of Kant, perhaps the only tool Jonas was missing was an empirical theory of self-organization and self-production. When Jonas formulated his thoughts, ideas about self-organization had been advanced in their early form (most visibly at the Brussels school led by I. Prigogine). Further, during the 1950s there was an emerging realization of importance of the role of non-linear or complex systems, starting a rapid development which culminated in the 1980s.[17]

Clearly, although not entirely new (since their early origins date back to the beginning of the century), these ideas were just not sedimented enough for Jonas to be aware of them in spite of the fundamental scientific mutation they represent by providing the rational keys for understanding how material structures can give rise to another level of organization without an external ad hoc coordination. This notion of a "whole being larger than the sum of the parts" has been familiar for a long time. But the rise of the studies on self-organization tells us just *how* the whole is more, and what type of causality is involved. Thus the tendency Jonas was stipulating for matter in his day was philosophically much more daring and speculative than it appears today. Matter, he argued, obviously had the natural tendency to display the "crazy caprice of the living" (Jonas 1973, p. 124). But one can do better than that: the emergent causality of the reciprocal passages between the local elements and the global emergent identity are not a caprice, but inscribed and endogenous to nature itself, a tendency rather than an irregularity.

It is at this junction in the history of ideas that the trends which Jonas incarnates so remarkably meet very deeply with what we have been referring to as the autopoiesis "school." This stems from the research of Humberto Maturana and Francisco Varela working in the early 1970s in Santiago, Chile.

Although both authors were hands-on biological researchers, they shared the same dissatisfaction with the dominant understanding of the living as molecular-genetic, as well as of the process of mind and cognition as information processing. Their active questioning of these dominant assumptions led over the years to the realization that what was missing was precisely the fact that life and cognition are actively done by an agent, an autonomous being who does not suffer passive world encounter, but fashions a world of meaning from within. It was this line of questioning that, in a backward suspension, led to the formulation of what could be said to be the *minimal* form of autonomy consistent with modern cell biology, and with the background of studies on self-organization and systems research circulating at the time (von Foerster, Rosenblatt, McCulloch, Wiener).[18]

Maturana and Varela formulated the notion of minimal autonomy as a circular process of self-production where the cellular metabolism and the surface membrane it produces are the key terms. Thus an autopoietic system – the minimal living organization – is one that continuously produces the components that specify it, while at the same time realizing it (the system) as a concrete unity in space and time, which makes the network of production of components possible. More precisely defined: An autopoietic system is organized (defined as unity) as a network of processes of production (synthesis and destruction) of components such that these components:

1. continuously regenerate the network that is producing them, and
2. constitute the system as a distinguishable unity in the domain in which they exist (Varela 1997, p. 75).

As we have said, autopoiesis has been explicitly formulated for the minimal living system, the cell. It is only natural that it has been strongly linked to the field of research concerned with the origins of life on earth, starting with pioneering studies of A. Oparin in the 1930s, and until today in the work of L. Margulis.[19] Now, it is clearly possible on this basis to *extend* this well-grounded notion of biological individuality beyond cellular life to a fully constituted multi-cellular organism. A multicellular organism (and this includes all vertebrates usually taken as prototypical organisms) is not in itself an autopoietic unit of second order, since its organization does not follow the same self-contructing principles. However, a multicellular organism inherits its autonomous nature and sense-making qualities through the configuration of its neural identity. This is a matter for a long discussion that cannot detain us here; it has been discussed *in extenso* elsewhere (Maturana and Varela 1984; Varela

1979, 1991). Thus when we speak here of the autopoeitic tradition we not only refer to the origin of life and the cell, but also, and by extension, to the life of the (multicellular) organisms *in toto*.

In its original formulation as well as in the subsequent literature it has been customary to see the central concept of autopoiesis as just one more self-organizing mechanism (which it undoubtedly is), and even to conflate it with dissipative structure or autocatalytic cycles, or mere open systems. These ideas basically stay within the perimeter of a physicalist view of nature and understand these new developments as necessary extension of classical physics. However there is a an essential difference between these views and autopoiesis: autopoiesis proposes an understanding of the radical transition to the existence of an individual, a relation of an organism with it-self, and the origin of "concern" based on its ongoing self-produced identity. One could envisage the circularity metabolism-membrane entirely from the outside (this is what most biochemists do). But this is not to deny that there is, at the same time, the instauration of a *point of view* provided by the self-construction. It is because of this phenomenologically open horizon that for Jonas also a mere cybernetic talk of regulation, hence of teleonomy, would not reach far enough in a description of the organism, whence his reluctance to accept this theory (see Jonas 1973, p. 185).

Thus autopoeisis is a singularity among self-organizing concepts in that it is on the one hand close to strictly empirical grounds, yet provides the decisive entry point into the origin of individuality and identity, connecting it, through multiple mediation with human lived body and experience, into the phenomenological realm. These are the mediations that Jonas addresses with so much force, and that makes these two lineages of thought not only contemporaneous but fully *complementary*. Both seek a hermeneutics of the living, that is, to understand from the inside the purpose and sense of the living.

3.4. *Autonomy and teleology*

Autopoietic biology – organisms are not only self-regulating but built from cells that materially establish themselves – therefore provides an open link with empirical biology and thus a link to a re-understanding of teleology as intrinsic or endogenous. Bluntly stated self-production is already and inevitably a self-affirmation that shows the organism as involved in the fundamental purpose of maintaining its identity. This is not a "mere" survival for survival's sake in a strong Darwinian sense:

> . . . the survival standard itself is inadequate for the evaluation of life. If mere assurance of permanence were the point that mattered, life should not have started out in the first place. . . . Not duration as such, but "duration of what?" is the question. (Jonas 1966, p. 106).

The key here is to realize that because there is an individuality that finds itself produced by itself it is *ipso facto* a locus of sensation and agency, a living impulse always already in relation with its world. There cannot be an individuality which is isolated and folded into itself. There can only be an individuality that copes, relates and couples with the surroundings, and inescapably provides its own world of sense. In other words by putting at the center the autonomy of even the minimal cellular organism we inescapably find an intrinsic teleology in two complementary modes. First, a *basic* purpose in the maintenance of its own identity, an affirmation of life. Second, directly emerging from the aspect of concern to affirm life, a *sense-creation* purpose whence meaning comes to its surrounding, introducing a difference between environment (the physical impacts it receives), and world (how that environment is evaluated from the point of view established by maintaining an identity).[20] Let us elaborate further on this point.

The organic coupling and change must, according to its self-constitution, be always directed to maintain the process of self-realization. An autopoietic system is necessarily referred to itself: its actions consist in establishing the dynamical processes of staying alive. Stimuli from outside enter the sphere of relevance of such a unit only by their existential meaning for the keeping of the process of self-establishment. They acquire a valence which is dual at its basis: attraction or rejection, approach or escape. Form, then, is not just an abstract goal in a genetic program, but a material task to fulfil from moment to moment. The genetic program influences form, but only in being interpreted by the soma according to the actual needs of self-maintenance. Without the individuality of the living body the program is nothing – a fact that runs counter to the Dawkinian conception where bodies are machines acting teleonomically to unfold the underlying program and to maintain it (here the genome has the status of an idealistic principle of reason creating artifacts).

Conversely, if we follow the autopoiesis-Jonas inversion, if we accept autopoiesis as embodied teleology, we reintroduce the subject into biology. The separation of the realm of pure natural science from the realm of values, so popular since neokantianism (Rickert 1920), has to be abandoned; instead a theory of embodied meaning has to be reintroduced into the science of the living, paying central attention to categories as value and subjectivity. By defining itself and thereby creating the domains of self and world, the organ-

ism creates a perspective which changes the world from a neutral place to an *Umwelt* that always means something in relation to the organism.[21] Organisms can be said to transcend the neutrality of pure physics and to create their concern. Only this organic perspective actually has the status of "world," only this is real, because the living can only act in the form of such an intentional world. Life is thus always subjective in the strong sense of the word.[22]

This conclusion can be seen as arising from a twofold difficulty unique to autopoietic systems. First, the organism has to remain in the field of physicochemical laws to maintain a "coupling" with the underlying energetical structures. Second, the organism does not follow a linear causality as it creates its behavior by its own regulation. So the environment gives the basis for the organism's behavior precisely in establishing a continuous challenge to it:

> The difference between environment and world is the *surplus of signification* which haunts the understanding of living and of cognition, and which is at the root of how the self becomes one. . . . There is no food significance in sucrose except when a bacterium swims upgradient and its metabolism uses the molecule in a way that allows its identity to continue. This surplus is obviously not indifferent to the regularities and texture (i.e., the "laws") that operate in the environment, that sucrose can create a gradient and traverse a cell membrane, and so on. On the contrary, the system's world is build *on* these regularities, which is what assures that it can maintain its coupling at all times. (Varela 1991, p. 86).

Only a small part of all dynamics in the environment enter as perturbations into the domain of relevance of the organism. All other possible interactions just fall outside of the possibilities of experience of the system. Only that which influences the steady state of the organisms is real – just because it *has* such an influence. It follows that every contact with the world has, for the organism, an existential meaning. Contact with the world is thus always value, prefiguring in a prototypal form the qualities the world will unfold later according to this background. The perspective of a challenged and self-affirming organism lays a new grid over the world: a ubiquitous scale of value. To have a world for an organism thus first and foremost means to have value which it brings forth by the very process of its identity:

> The fundamental point of departure is that life says "Yes!" to itself. In wishing itself to continue it declares itself as a value . . . May we thus say that mortality is the narrow door through which *value* – the thing addressed by "yes" entered the otherwise indifferent universe? (Jonas 1992, p. 87).

The primordial structure of value then manifests in what can be now be called the subjective dimension even for the simplest organisms. Only in the light of the "desire" of the living, does the world gain structure and gestalt, and those

are only understandable in the light of these existential needs. A world without organisms would be a world without meaning; and it is in life's incessant need, that a subjective perspective is established. Subjectivity is the absolute interest the organism takes in his continued existence. Its experience is at the same time, as the basic biological feature, the direct junction of human experience with the remainder of creation. [23]

The dichotomy between process and substrate is bridged factually in every moment by the total identity between process and substrate. This encapsulates the whole scale of an organic phenomenology as formulated both by Jonas and autopoiesis: subjectivity, intentionality, and meaning. In its nucleus lies the antinomy of substrate dependence and autonomy. This is, for Jonas, life's main characteristic: its Janus-faced doubling between necessity and freedom:

> . . . for the first time within being the difference between substance and form, which is a pure abstraction when applied to the inorganic, becomes a real distinction. This implies a complete inversion of the ontological relationship: Form has become the essential, and substance has become the accidental. (Jonas 1973, p. 125).

Necessary then are the material compounds of an organism, their incessant input and their unhindered supply. But this necessity again is governed by a principle of autonomy – or, as Jonas says, *freedom*: the fact, that a living system is able to become an ontological center, that it is able to organize itself into a form that is not explainable by the features of the underlying matter (the pure necessity) alone. This autonomy then is nothing other than true teleological behavior. This autonomy has to do with the ever existing gap between the realization of the living and its underlying matter. Because form that desires itself in a purposeful manner is happening only in matter to which form is *not* its entropically "natural" state, there is always the possibility, and final certainty, of death. It is this existential situation that is emphasized by Jonas: the teleological, circular, self-referential movement of the living. To live means to say yes to oneself emphatically as the basic movement of existence, because existence is always existence of form on and against pure matter.

To speak of freedom or autonomy thus directly links the biological sphere with a teleological account of ontology. On a material, concrete level we can observe in the organism the flip side of mechanical causality, a final causality as the basic process of life itself – the establishment of an identity. But this happens not by revising physical laws for particle-interactions in special application to organisms, nor by imposing an extra-mechanical entelechy. It is rather the "subject-pole" that is the organism in its autonomy, which changes linear causality by structuring matter in the process of self-realization to maintain itself as this very process.

4. Life after Kant: An immodest conclusion

It is now time to draw this discussion to a close and to state its main conclusion, which is double. On the one hand, only by considering the embodied organism as self-producing individuality can we re-formulate a strong notion of an intrinsic teleology. On the other hand the converse is also true: in admitting biological individuality, and hence the precariousness of the living, we cannot evade the teleology that is intrinsic to life thus understood.

It is already amazing that Kant (KdU, § 65, 374) had given a visionary account of self-organization that anticipates the definition of autopoiesis almost literally, but within the bounds of a transcendental analysis. It is characteristic that also Jonas offers an autopoietic criterion defining life: for him, this is metabolism, if unfolded into its full scope of phenomenological consequences. Given that autopoiesis emerged within science to address the same concerns, the interpretative circle becomes complete, spanning the Kantian lineage into new insights concerning natural purposes.

So, as we have seen, if we follow the conclusions from autopoietic biology, we find an absoluteness of self-interest emerging immediately as a kind of intrinsic or endogenous ontological teleology. In this respect autopoiesis is the necessary empirical ground for Jonas' theory of value. Together both theories give an empirical background for the *Leibapriori* found in the late works of Kant, and together they can resolve the aporias about organic purposefulness in the *Critique of Judgement*. Teleology, understood as intrinsic teleology, turns out to be an empirical feature of an organism, its *sine qua non* condition. But this is objective not in an absolute sense, only insofar as an organism is a center that organizes matter into a living being and its *Umwelt*, hence enacting on this stage the original split of subject and its world and their dialectical interrelatedness.

In the end, what we rediscover here is not so different from what Kant meant when he invoked the *intellectus archetypus* who could understand biological realities directly in an intuitive way – an insight Kant denied for man for all times to come. But our individual perspective as being animate matter is nothing less than this *intellectus archetypus*, which is thus an *embodied* intellect. This embodiment enables in us a basic evidence (as Jonas is inclined to say), an *intuition* given us by the right of our factual membership in the organic world. As being part of that, we have an intuitive, embodied access to it – being a part of how our *aprioric* conceptions are structured biologically.

Our immodest conclusion is that Kant, though foreseeing the impossibility of a purely mechanical, Newtonian account of life, nonetheless was wrong in denying the possibility of a coherent explanation of the organism. But this

"Newton of the Grassblade" was surely not Darwin, who offered a Newtonian theory for biological form. The fuller understanding of the organism needs a different approach. The real "Newton of the grassblade" was not to be an individual person, but a historical convergence of philosophical and biological thinking into a solidarious cauldron. This disseminated Newton, whose shape we have outlined along these pages, offered exactly the required Copernican turn: an objective account of biological individuality that joins in circle with the constitution of a subject.

We conclude that it is possible to go beyond Kant in an account of life and purpose. But only after almost two centuries and radically new developments in both science and philosophical research. We truly stand on the shoulders of a giant.

Notes

1. See Reference list A for a bibliography of the pertinent literature.
2. For the best source on this history see: Spaemann and Löw (1981).
3. All translations from German texts by the authors.
4. With the theory of selection Darwin seemed to have "discovered" the mechanistic principle underlying purposiveness of design, and thus some saw in him the "Newton of the grassbalde". For more on this argument see Plessner (1982) and Cornell (1986).
5. For this discussion see e.g., Gould (1991), Kauffman (1998), Maturana and Varela (1980), Rose (1998), Weber and Depew (1996) and Webster and Goodwin (1982).
6. For this criticism see e.g., Lewontin (1983), Salthe (1993) and Strohmann (1997); for a discussion of these problems from an adaptionist side see Rosenberg (1996), especially p. 189.
7. But see Maturana and Varela (1991) and Varela, Thompson, and Rosch (1991). For similar concerns arising in Artificial Intelligence/Artificial Life and their failure to construct intelligent machines viz. artificial organisms by a symbol processing approach see Boaden (1996).
8. The *Critique of Pure Reason* is quoted (as KrV) according to the German second ("B") edition, followed by the page. The *Critique of Judgement* is quoted (as KdU hereinafter) according to Vol. V of the *Preußische Akademie-Ausgabe* (*Akad.-A.*), Berlin 1910 ff., with section and page (The *Akademie* pagination appears also in the margin of e.g., the J. C. Meredith (Oxford 1928) translation of the *Critique of Judgement*). The *Opus Posthumum*, as well as all other texts by Kant are quoted according to the *Akad.-A*. As there is no English standard translation to refer to, and because translations are not always in accordance with the author's views, all translations are by the authors (A similar proceeding has been followed by McFarland 1970, p. ix).
9. See (KdU, introduction, p. 183): "Also müssen wir in der Natur, in Ansehung ihrer bloß empirischen Gesetze, eine Möglichkeit unendlich mannigfaltiger empirischer Gesetze denken, die für unsere Einsicht dennoch zufällig sind (apriori nicht erkannt werden können)."

10. See also Merleau-Ponty (1994, p. 43 passim). As he rightly saw, Kant deals here with the problem of the ”other” vis-à-vis his idealism.
11. Actually Kant's work reflects *in nuce* the whole mind-body problem that arose subsequently to the program of modern science. Kant's philosophy in the whole can be viewed as an attempt to overcome this gap, starting with the reductionist monism of the subject constructing the categorial world. For this point see Merleau-Ponty (1994, p. 40).
12. See for instance Gould (1991) and Rose (1998); also Varela et al. (1991, Chapter 8).
13. Helmuth Plessner, another important philosopher of the organism, takes a parallel view in his 1928 (3rd edition 1975) landmark book *Die Stufen des Organischen und der Mensch*.
14. For a prolongation of this argument in ethics see Hösle (1994). See also Nussbaum and Sen (1993).
15. This line of thinking is, in fact, rooted in a long tradition in German philosophy that witnessed an unusually fruitful period before World War II, with protagonists such as J. v. Uexküll and Helmuth Plessner – both biologists by formation – whose works should revaluated again. Concerning von Uexküll, see the valuable work of Harrington (1996).
16 For a recent account of why this analysis fails to reach the very origin of life see Barbaras (1999).
17. For representative discussions in biology in the eighties and nineties, see Goodwin and Saunders (1989), Jantsch (1980), Kauffman (1993) and Stein and Varela (1991).
18. For the historical background of autopoisis see Varela (1996).
19. See Oparin (1938). For discussion of the origins-of-life research tradition going back to Oparin, see Lazcano (1995). For recent dicussion see Deamer and Fleischaker (1994), Fleischaker (1990), Margulis and Sagan (1995) and Morowitz (1992).
20. This is discussed extensively in Varela (1977).
21. The notion of Umwelt is due to J. v. Uexküll.
22. For a phenomenological interpretation of this idea see Varela and Depraz (1999).
23. The phenomenologically oriented reader will not fail to see the strong connections with many similar concerns in the work of Merleau-Ponty's early work, specially as reformulated recently by R. Barbaras (1999), where the centrality of active movement is understood as rooted on the primordial quality of life. Surprisingly however, these basic living sources are never thematized as such, but only as they shine forth from higher animals and man. As stated before, we differ here (with Jonas) in pressing for the roots of such sense-making in the explicit roots of life.

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