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ARTICLE

The 'Whole' Truth about Biological Individuality in Kant's Account of Living Nature

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Abstract

Given the central place organisms occupy in Kant's account of living nature, it might seem unlikely that his claims about biological wholes could be relevant to current debates over the problem of biological individuality. These debates acknowledge the multiple realizability of biological individuality in vastly different forms, including *parts* of organisms and complex *groups* of organisms at various levels of the biological hierarchy, sparking much controversy in attempts to characterize a biological individual. I argue that, far from being irrelevant to this controversy, Kant's account provides a key insight for addressing the multiple realizability problem. I show how the *reciprocal causality* between a self-organizing whole and its parts, which Kant thinks characterizes a *natural end*, is not limited to organisms but is exhibited by numerous types of beings in living nature. Self-organizing wholes of various kinds, and at various biological levels, may count as biological individuals, depending on the degree to which their functionally integrated parts are *represented* by reflective judgement as a natural end.

Keywords: biological individuality; biological wholes; functional integration; organisms; Kant; self-organization; natural ends; purposiveness; living nature; reciprocal causality

1. Introduction

When Kant proposed the idea that a subdiscipline of natural science ought to be established that undertakes the examination of 'self-organizing beings' (*sich selbst organisierende Wesen*), he could not have anticipated the overwhelmingly extensive range of living nature that would constitute the subject matter of this discipline. While his own notion of self-organizing beings was limited to organisms, over the span of more than two centuries this new discipline, which developed into *biology*, has steadily broadened its scope far beyond the organismal domain, to include biological entities both above and below the level of the organism. The multiple realizability of biological individuality in such vastly disparate forms and at various levels of the biological hierarchy of organization has led to much confusion and disagreement about how a biological individual is to be characterized.

Because of the many contending views and lack of consensus on the defining features of biological individuality, a pluralist approach presents itself as the most

viable to some, especially as different criteria are required by different aims and contexts of biological investigation (Godfrey-Smith 2013; Booth 2014; Love and Brigandt 2017). A more radical view still is that of *eliminativism*, which claims that biology can simply do without the concept of a biological individual, since nothing important hangs on it (Gilbert et al. 2012; Okasha 2018). In contrast to such positions, some still argue that a monist approach to biological individuality based on a unifying concept is indispensable for a coherent and useful system of biological explanation. (Pepper and Herron 2008; Clarke 2010, 2013). The explanatory and predictive descriptions involved in biologists' accounts of evolutionary processes involve distinguishing between particular biological units. This, however, requires a basis for counting some units and not others, that is, an ability to distinguish the relevant biological units from all the others (Clarke 2010; Godfrey-Smith 2013). In population biology, it must be possible not only 'to distinguish individuals in a population from their neighbours synchronically' (Booth 2014: 11); calculating fitness also requires the capacity 'to distinguish parents from their offspring diachronically' (Booth 2014: 11), as well as to discern the evolution of new kinds of individuals. We need to be able to determine 'when we have production of a *new* individual as opposed to continuation of the old one' (Godfrey-Smith 2009: 73). I aim to show how a Kantian understanding of the unique *part/whole relation* characterizing the organic entities on this complex spectrum provides some needed direction for current debates over biological individuality.

Turning to Kant for conceptual clarity provides the foundation for a pluralist approach on an *empirical* level, while offering a unifying strategy for a monist view on an *epistemic* level. Given the parameters of a Kantian framework, I maintain that the most promising empirical accounts of biological individuality are those that adopt an essentially functionalist view, since the notion of functional integration, in a constitutive sense, accords most closely with the feature of *reciprocal causality of part and whole*, which Kant thinks fundamentally characterizes the regulative notion of a *natural end*, that is, self-organizing being (*CJ,* 5: 376–7).[1]

I advance my argument for this position in four sections. Section 2 examines some current perspectives on biological individuality, highlighting some central challenges in tackling the multiple realizability problem. I then demonstrate the relevance of Kant's account of living nature to this contemporary project and explore the possibility of accommodating the multiple realizability of biological individuality in a Kantian framework. In section 3, I explain the unique relation in self-organizing beings – *the reciprocal causality of part and whole* – and how this relation serves as the basis for a functionalist account of biological individuality. I stress here the importance of acknowledging the regulative status of the concept of a biological *whole*, to avoid viewing the teleological character of self-organizing beings as a constitutive feature of nature itself. Section 4 highlights the point that the relation of reciprocal causality of part and whole is manifested by biological entities in varying degrees, and on different levels of the biological hierarchy. This entails that numerous types of organic entities besides organisms qualify as biological individuals – though some more than others. I show how this supports a pluralist view of biological individuality on an *empirical* level. In section 5, I stress that, nonetheless, a Kantian standpoint grounds a monist account of biological individuality on an *epistemic* level, insofar as it is understood as a merely regulative

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concept of reflecting judgement that serves as an ineliminable principle of cognition for the study of living nature.

2. Beyond the organism – can Kant's framework accommodate the multiple realizability of biological individuality?

Biological individuality has been a topic of interest for researchers and philosophers of biology for over two centuries. The complex forms of biological phenomena revealed by contemporary biology have necessitated a radical extension of the explanatory concepts operative in eighteenth- and nineteenth-century natural philosophy (Huneman 2006; Lidgard and Nyhart 2017; Wilson and Barker 2019). This includes the acknowledgement of about twenty-four different criteria of biological individuality (Lidgard and Nyhart 2017: 18–23). While organisms have traditionally been regarded as paradigmatic biological individuals by both philosophers of biology and biologists alike, that paradigm has been displaced to make room for numerous biological phenomena both above the level of the organism and below (Pepper and Herron 2008; Dupré and O'Malley 2009; Bouchard and Huneman 2013).[2] These include genes, cells, species, colonies and multispecies symbiotic communities, i.e. holobionts.[3] The multiple realizability of biological individuality in these broad-ranging forms has frustrated the attempts of philosophers of biology to discern a defining set of features that apply to all. Especially problematic is that this broad spectrum of biological entities presents biologists with competing criteria of biological individuality. These criteria include physiological, evolutionary, genetic, metabolic, reproductive, developmental and immunological features, among many others. Disagreement over the comparative importance and relevance of these criteria poses serious challenges for devising a consistent strategy for identifying what qualifies as a biological individual.

The various combinations of these criteria have yielded two prominent views of biological individuality: the *physiological view* and the *evolutionary view* (Pradeu 2016). On the physiological view, biological individuals are generally characterized by criteria such as having a metabolism, possessing functional parts unified into a physically bounded cohesive and autonomous whole, and having internal mechanisms that regulate physiological processes. This view is essentially concerned with mechanistic explanations (Pepper and Herron 2008: 622–3). On the evolutionary view, biological individuals are typically characterized by factors such as genetic homogeneity, reproductive processes, life cycles, lineages and their status as units of selection. This view focuses on explaining the distribution of traits in populations through natural selection processes, fitness levels and adaptations (Clarke 2013).

Regardless of the general approach, these naturalistic accounts of biological individuality initially strike one as completely at odds with Kant's conception of living nature in several ways. Given the radical developments in the study of biological phenomena since Kant's time, it may be questioned whether Kant's organism-centred account of living nature remains at all relevant to present-day discussions. Also, it does not seem possible to square contemporary naturalist theories of biological individuality with Kant's, since Kant's account is fundamentally teleological, in viewing organisms as purposive. I argue that, although current philosophers of

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biology are confronted with a vastly richer landscape to inform their notion of biological individuality, a Kantian framework may not only accommodate these new empirical findings but also supply the *epistemic ground* for the study of biological individuals that current accounts lack. Ultimately, I show that Kant's insights support a pluralist approach to biological individuality on an *empirical* level, while at the same time establishing a focal point for a monist view on an *epistemic* level.

I maintain that, guided by Kant's account of organismality, what counts as a biological individual depends on the various ways in which biological phenomena may be reasonably partitioned into unified functional *wholes*, as opposed to mere heaps or aggregates. According to Kant, this partitioning is warranted when a certain relation exists between a set of parts that we *judge* to be (a) engaging in reciprocal causality with each other and with the whole of which they are parts, and (b) self-organizing in accordance with an intrinsic end. This type of being is distinguished from an *extrinsic end* which is designed by a rational agent for some purpose external to itself, for example, a light bulb. Kant refers to these types of biological phenomena as *natural ends* (*CJ,* 5: 372–4). Kant's characterization of the fundamental feature of organisms that renders them *natural ends* is their manifestation of *reciprocal causality*. This involves two aspects: 'a thing exists as a natural end if it is cause and effect of itself (although in a two-fold sense)' (*CJ,* 5: 370–1). This two-fold sense is to be understood in this way: 'first, that its parts (as far as their existence and their form are concerned) are possible only through their relation to the whole', and 'second, that its parts be combined into a whole by being reciprocally the cause and effect of their form' (*CJ,* 5: 373). The example Kant provides of a natural end in this passage is a tree, which undergoes three types of generation due to the reciprocal action of its parts: (a) generation of the species, through reproduction, (b) generation of the individual, through growth, and (c) generation of the parts, through preservation. In none of these types of generation, Kant claims, can the activity of the tree be understood as the product of some *external mechanism*. Rather, it must be understood as the product of some *internal* source of self-organization, an intrinsic *formative power* that gives rise to the reciprocal causality of parts and whole (*CJ,* 5: 371–2, 374). Any instance of living nature that exhibits this feature to our judgement may be viewed as a biological individual. Kant asserts that organisms are the type of beings that the study of biology requires us to conceive in this way. Thus, if directed by Kant's criteria of the unique part/whole relation exhibited by certain kinds of biological phenomena, biological individuality asserts itself on the level of organisms.

There is nothing in Kant's account, however, that precludes the possibility of partitioning biological phenomena into these kinds of wholes on other levels of the organizational hierarchy as well, as I shall show. Although there is no explicit indication in the Kantian texts that Kant thinks reciprocal causality and goal-directed self-organization characterize other kinds of biological wholes besides organisms, there is, I think, strong basis for the claim that the part/whole relation Kant identifies as a natural end does not assert itself *only* on the organism level. Other biological phenomena that exhibit this unique part/whole relation also qualify as biological individuals. In fact, in his discussion of the tree example presented above, Kant exhibits a broader view of his concept of a natural end, which suggests that the 'whole' that may be considered a natural end may be an individual organism (the individual tree), the species (a plurality of trees as members of a

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species), and the parts of an organism (the leaves, twigs, etc., of the tree). The first depicts the paradigmatic case of the organism level. The second captures the species level. The third includes the sub-organism level. In connection with the species level, Kant explains that 'the tree that it generates is of the same species; and so it generates itself as far as the species is concerned, in which it, on the one side as effect, on the other as cause, unceasingly produces itself' (*CJ,* 5: 371). In connection with the sub-organism level, Kant points out that 'one can regard every twig or leaf of one tree as merely grafted or inoculated into it, hence as a tree existing in itself, which only depends on the other and nourishes itself parasitically' (*CJ,* 5: 371–2). This suggests that both the *species* of the tree and the *parts* of the tree are generated and preserved as natural ends in their own right. Both appear to satisfy Kant's criterion that 'an organized product of nature is that in which everything is an end and reciprocally a means as well' (*CJ,* 5: 376). Thus, although Kant generally tends to attribute the part/whole relation of reciprocal causality to organisms, he intimates that this relation may, nonetheless, be manifested both above and below the organism level.

This teleological characterization of organic beings underscores Kant's conviction that biology must proceed 'as if' the objects it studies were *natural purposes*, that is, governed by final and not merely efficient causes, in a manner analogous to human intentional agency. This view is further exemplified in the *Opus Postumum* where Kant explains that 'the idea of organic bodies is *indirectly* contained *a priori* in that of a composite of moving forces, in which the concept of a real *whole* necessarily precedes that of its parts – which can only be thought by the concept of a combination according to *purposes*' (*OP,* 21: 213). Kant asserts that, although as a *mechanism*, this purposive whole can only be known empirically, as an 'organic-moving force' it is to be understood on analogy with a human body as a 'self-moving machine' excitable by intention and desire (*OP,* 21: 213).

Kant stresses, however, that teleological principles are merely to be considered *regulative principles* for the reflective power of judgement as opposed to *constitutive principles* of the understanding that yield cognition of objects (*CJ,* 5: 372–4; McLaughlin 1990; Breitenbach 2021). That is, these teleological principles are required for our *representation* of organic nature; they are not to be viewed as *constitutive* of organic nature. This entails that the purposiveness we detect and attribute to living nature is not to be viewed as characterizing nature in an objective manner, but only with respect to our way of representing nature to ourselves through the reflective power of judgement, as is required for the study of organisms (*CJ,* 5: 379; Ginsborg 2001, 2006; Breitenbach 2009). The unique nature of organisms, Kant maintains, requires a special science to investigate them, which eventually became *biology*. Kant could not have imagined the various subdisciplines into which biology would be divided about a couple of centuries later, and how profoundly their differing methodologies would conflict in the attempt to provide an adequate account of organisms and their status in biological inquiry in general.

The fault line emerges prominently between physiology and evolutionary biology. While the organism traditionally occupied the focal point in physiology, it receded in the background in evolutionary theory, which focuses on the *change of gene frequencies in populations*, only to make a comeback in the latter half of the twentieth century through the innovative interpretations of evolutionary theory in the work of

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Ernst Mayr, David Hull and others (Mayr 1997: 2093; Hull 1980: 318).[4] On this organism-centred view, the developing organism, as an integrated whole, cannot simply be viewed as the *product* of genes since it is already presupposed in the activity of the alleles and in gene activation (Huneman 2010: 358). This approach places organisms at the centre of evolutionary processes. Interacting with its environment, the organism is the unit on which selective forces act, and it is through *its* proliferation that its constituent replicators are copied and perpetuated. While evolution acts on a population, natural selection typically acts 'on the level of the individual organism' (Pepper and Herron 2008: 622).

Peter Godfrey-Smith (2013) and Austin Booth (2014) distinguish between two basic categories of biological individuals: *organisms* (metabolic beings, which serve the physiological view) and *Darwinian individuals* (units of selection, which serve the evolutionary view). Godfrey-Smith and Booth maintain that, although these may overlap in some cases, they need not.[5] For this reason, they argue, we should avoid conflating these distinct notions, as doing so yields conflicting claims in the attempt to devise a monistic view of biological individuality. Some, however, such as Ellen Clarke (2013), contend that biological individuals are paradigmatically organisms, and that it is not possible to engage in any type of biological inquiry which does not presuppose them, rendering a monistic view not only possible but necessary on this basis.[6] It is precisely this *presupposition* of the organism that I wish to examine.[7] Specifying what it is about organisms that has fixed their position as a crucial reference point in biological inquiry (even on some interpretations of the Modern Synthesis) is necessary groundwork for an analysis of biological individuality. In the ensuing sections, I explore Kant's contribution to this groundwork.[8]

3. The part/whole relation in Kant's account of self-organizing beings as the basis for biological individuality

Frequently included on the list of central traits of biological individuals is that of *functional integration* – especially in the accounts of D. C. Queller and J. E. Strassmann (2009) and Clarke (2013). Functional integration, however, is not unique to biological individuals. Those who appeal to functional integration as characterizing biological individuals tend to supplement it with the capacity for self-maintenance (homeostasis) and autonomous activity (Booth 2014). On no other *philosophical* view are self-maintenance and autonomy more central than on Kant's account of natural ends. According to Kant, this type of functional integration consists in the reciprocal causality of the parts, guided by the idea of a whole that grounds the unity of those parts, resulting in a *self-organized* and *self-organizing* being (*CJ*, 5: 372–4). It is the fact that this functional integration originates within the biological being itself that renders it a *natural end*, in contrast to a functionally integrated artefact. While this crucial qualification is paramount for an adequate understanding of organisms, it also has significant utility for discerning other types of biological individuals besides organisms.

The central premise of my position is that it is not the *organism* but rather its unique part/whole relation that is determinative of biological individuality – what Kant refers to as *natural purposiveness*. This part/whole relation is the reciprocal causality in a *self-organized* and *self-organizing* being. In fact, Kant does not employ the

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term 'organism' at all in the third *Critique*, only in the *Opus Postumum* (Wolfe 2010). The term he uses consistently is 'self-organizing being', which highlights the *functional integration* that unifies the parts into an autonomous, well-coordinated whole. On Kant's view, this feature is most clearly manifested by organisms. Organisms are autonomous, functionally integrated entities and not mere collections of discrete objects (Gould and Lewontin 1979). The part/whole relation they exhibit – a mereological relation – is not equivalent to a set membership relation.[9] A biological individual, considered as a whole, is not simply the totality of its parts, but the representation of those parts as autonomously and functionally integrated in the form of a natural end (*CJ,* 5: 373–4). This, I argue, amounts to a *functionalist* conception of a natural end.

On this basis, we judge an organism *as if* it were a *natural end*, an end of nature. Kant stresses that the feature of organisms that renders them distinct from other organized beings is that the source of the organization is not external to the organism but rather internal (*CJ,* 5: 374). For this reason, organic beings are not entirely reducible to merely mechanistic activity, and thus are underdetermined by the laws of physics (McLaughlin 1990).[10] According to Hannah Ginsborg (2001: 245),

> when Kant says that we cannot conceive of how unorganized matter left to its own workings could spontaneously form itself into an organism, his point is that the regularities exhibited by organisms cannot be accounted for in terms of fundamental regularities that characterize the behaviour of matter at the most general level.

Kant distinguishes this type of self-organization, which involves a *formative power,* from that of a machine, which only involves a *motive power* by virtue of its constituent matter (*MFNS,* 4: 536–7; *CJ,* 5: 374). This distinctive 'self-propagating formative power', Kant claims, is 'communicated' to the matter, and in this way organizes it – a process inexplicable by means of purely mechanistic causes (*CJ*, 5: 374).[11] As van den Berg (2014: 129) explains, this formative power is exhibited through three particular traits, which are, in fact, the traits that lead us to think of an organism as both 'cause and effect of itself' (*CJ*, 5: 371). These are: generation (propagation), nutrition and regeneration (reproduction). Kant seems to follow J. F. Blumenbach here, who had singled out these traits as the features of beings that demarcate the particular domain of 'natural history' we now call 'biology' (van den Berg 2014: 129).[12]

In the reciprocal part/whole relation characterizing natural ends, it is not problematic to understand how the parts can be the cause of the whole, that is, mechanistic causality. It is the other requirement of the reciprocal relation – the whole as the cause of its parts – that poses a challenge, as this would appear to imply a non-mechanistic, genuinely teleological causality.[13] To avoid this, Kant explains, the whole is to be conceived not as the *real* or *actual* cause of its constituent parts. He writes, '[it is] entirely contrary to the nature of physical-mechanical causes that the whole should be the cause of the possibility of its parts' (FI, 20: 236). Rather, the *whole* here is to be understood as resulting from the relation of *ideal* causes, which Kant refers to as the *nexus finalis* (*CJ,* 5: 372–3).

On this view, it is the *representation* of a whole that we are to view as the cause of its constituent parts, which themselves serve as the efficient causes of the whole. By

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viewing the *whole* as merely a *representation*, Kant avoids the problems of *intentionality in nature* and *backwards causality*.[14] However, van den Berg (2014: 129) stresses that,

> For Kant this representation is not the actual cause of the organism. This would be to introduce intentional causality in nature and to affirm that organisms are objects of design [as the rationalists maintained]. Hence, we only treat organisms *as if* designed. It is by *analogy* with human purposive action, i.e., action in accordance with representations, that we construe organisms as natural purposes.

It is paramount for Kant that the idea of a whole operative in self-organizing beings in nature is conceived solely as 'a ground for the cognition [*Erkenntnisgrund*] of the systematic unity of the form and the combination of all of the manifold that is contained in the given material for someone who judges it' (*CJ,* 5: 373). Importantly, this cognitive ground should not be conflated with an *explanatory ground,* that is, a mechanism in nature itself.[15] This would amount to invoking some type of purposiveness in nature, distinct from the intentional agency and *end-setting* of a rational being (Breitenbach 2009; Gambarotto and Nahas 2022) – a view Kant sought to dispel from the natural philosophy of his time.[16]

The utility of appealing to Kant's criterion of reciprocal causality to address the problem of biological individuality is that it enables us to acknowledge that the concept of a *whole* operative in the notion of reciprocal causality, which imparts design to its parts, is a merely *regulative* concept rather than a constitutive concept.[17] As a regulative concept, it issues from the reflecting power of judgement, and serves as a necessary tool for biological inquiry and for systematizing our reflection in such inquiry (*CJ,* 5: 375–7).[18] As Kant states, 'by its means we acquire only a guideline for considering things in nature' (*CJ,* 5: 379). This concept of a biological whole is not, as is typically presumed, an empirical concept that corresponds to an empirical object – which is precisely what contemporary views of biological individuality appear to demand (Steigerwald 2006). The concept of a whole in living nature, conceived *as if* it imparts an intrinsic purpose or function to the operation of its parts can never be discovered by the mechanical laws of nature governing the efficient causality operative in empirical reality. Kant, however, also guards against our misconstruing this concept of the whole as functioning in a genuinely teleological way, in a manner identical to that of the causality of a rational being, that is, an intentional agent, as this would presuppose an intentional, supernatural causality in nature itself (*CJ,* 5: 372–3).[19]

Some interpret this regulative concept as a merely *heuristic* device that makes it convenient for biologists to study the form and function of organisms in ultimately mechanistic terms. Others interpret it as something more substantial, which may facilitate a *naturalistic* account of the teleological character of living nature (Gambarotto and Nahas 2022). I suggest that this regulative concept is neither a merely heuristic device – as it is not an arbitrary or optional tool – nor is it something that can be naturalized by some 'Newton of the grass blade' (*CJ,* 5: 400). Rather, the regulative concept of a biological whole is necessary in the sense that, although it is merely ideal, it is required for judging the parts as the components of an organic being.[20] It is necessary for judging the parts as composing a functionally integrated

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and self-organizing being, a biological individual, and not just an aggregate of items. Thus, although the idea of a biological individual, considered as a self-organizing *whole,* is itself ideal, it makes possible the reality of the functional integration of the *parts* conceived as a natural end.

4. Degrees of biological individuality – why some *wholes* are more whole than others

Probing the part/whole relation in organisms further, Kant's position appears to accommodate a variety of levels of biological *wholes*, and thus a variety of types of natural ends, since Kant views as a natural end that which appears *as if* it exhibits self-organization of its parts, guided by the integrative, end-orientated concept of the whole. This position approximates a functionalist view of biological individuality, which renders possible not only different forms of biological individuals but also a hierarchy of such individuals, as well as biological individuals nested within other biological individuals. As Kant explains,

> the cause that provides the appropriate material, modifies it, forms it, and deposits it in its appropriate place must always be judged teleologically, so that everything in it must be considered as organized, and everything is also, in a certain relation to the thing itself, an organ in turn. (*CJ,* 5: 377)

Although this is not an explicit statement that organisms may be composed of other organisms, Kant appears at least to be opening the door to this possibility. Because an organism is that which is self-organized in the manner described above, and because an organism may be composed of parts, which themselves are self-organized in a similar manner, an organism may contain other organisms – though in relation to the whole organism, these constituent organisms are more properly considered 'organs'.

Interestingly, organisms, conceived as natural ends possessing the power to control and regulate their goal-orientated parts, also 'constitute the ground for the possibility of sub-organismal, replicator biology' (Walsh 2006: 780–1) in the Modern Synthesis view discussed above. This is because the parts of organisms need not themselves be *organisms*, only self-organizing functional unities. Kant's account, with its regulative concepts properly construed, offers support for a functionalist approach to biological individuality, since first, it is rooted in the integrative function of the mechanisms that unify the parts into a coordinated whole, and secondly, it locates the whole among the representations of the reflective power of judgement, as opposed to the empirical objects in nature itself.

A functionalist approach to biological individuality, I maintain, is rendered more plausible in conjunction with the precept that the integrative activity of biological individuals, as well as their reproductive capacity, admits of degrees – a view advanced by Queller and Strassmann (2009), Godfrey-Smith (2009) and Clarke (2013), among others. That is, in some biological individuals the parts may be more functionally integrated than in others, which increases their reproductive capacity in comparison with others, thereby promoting their fitness. Combining these notions, Clarke (2013) maintains that the type of functional integration that promotes an entity's capacity to undergo selection is determinative of biological individuality. She contends that organisms display the

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greatest degree of this type of functional integration, and for this reason also exhibit the greatest degree of biological individuality. Kant's own functionalist account of natural ends substantiates this position, as I will show.

Acknowledging the concept of a biological whole as merely regulative rather than constitutive is a critical move for the tenability of this functionalist view. This move is further facilitated by construing the criterion of reciprocal causality that fundamentally characterizes the part/whole relation in Kant's natural ends, as *admitting of degrees*. Although Kant does not make this point explicit in the *Critique of Judgement*, recent scholarship provides substantial evidence that Kant was moving in this direction in his broader system of nature, which may be viewed as having paved the way for the study of ecology. Georg Toepfer finds evidence for this view in Kant's notion of 'organizing systems of organized bodies', which Kant discusses in the *Opus Postumum* (Toepfer 2019: 7). At least rudimentarily, Kant appears to 'extend his teleological reflection from the singular organism to a superindividual system and envisions an ecological system based on the reciprocal relation between living beings of different species' (Toepfer 2019: 3).

While Kant reserves the notion of 'natural end' (*Naturzweck*) for individual organisms only (Toepfer 2019), crucial passages in the *Opus Postumum* reveal the extension of Kant's thought beyond the organismic boundary. Toepfer (2019: 3) argues that by 1799 Kant was concerned to devise a proper formulation of *superorganismic organizations.* This notion captures the idea of an 'organization of a whole consisting of different species of organized beings serving each other and their preservation' (*OP,* 22: 300) and of an 'organization of a system of organized beings, e.g., deer for the wolf, mosses for the tree, soil for the crop' (*OP,* 22: 505).[21] Kant claims that 'nature does not only organize matter into bodies but these in turn into corporations [*Corporationen*] which for their part have relationships of reciprocal purposiveness (one being there for the sake of the other)' (*OP,* 22: 506). Moreover, Kant maintains that the concept of a natural end 'necessarily leads to the idea of the whole of nature as a system in accordance with the rule of ends' (*CJ,* 5: 377–9; Breitenbach 2017: 253). These passages demonstrate how broadly Kant's notions of reciprocal causality, self-organization and natural purposiveness may be applied across the biological and ecological spectrum, as they extend also to superorganisms and holobionts. Toepfer points out that 'for Kant, "organized bodies" exist on various levels as individual organisms, particular ecological systems, and the entire earth' (Toepfer 2019: 8). I maintain that these passages exemplify even more than what Toepfer suggests. They *not only* serve as evidence of how broadly Kant's notion of 'self-organization' may be applied in living nature, that is, that it may extend beyond the organism to ecological systems; they *also* suggest that nature exhibits self-organization in *varying degrees*, depending on the strength of the relation of reciprocal causality between parts and whole – since the part/whole causal relationship manifested in the self-organization of ecological systems is typically considered to be significantly looser than the part/whole causal relationship exhibited by organisms. Although this may be a reconstruction of Kant's position, it strikes me as well-founded. On this view, Kant's position allows for a system of biological wholes within biological wholes – depending on the degree of reciprocal causality of parts and whole, which in turn determines the degree of functional integration.

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That the parts of a biological whole could be so functionally integrated that they themselves could be viewed as biological wholes is not only consonant with Kant's acknowledgement of 'systems of organized beings', as evidenced by his ecological theory, it is also reflected in his conception of organisms as 'parts' of species – a position inspired by G. L. Comte de Buffon.[22] Kant's endorsement of Buffon's view that species could be viewed as *historical individuals* is further corroboration that he was implicitly open to viewing biological individuality as admitting of different forms and degrees.[23] In consideration of this broader scope, it is clear that Kant had taken the initial steps towards acknowledging the multiple realizability of biological individuality as a consequence of the various ways in which the relation of reciprocal causality manifests itself in living nature.[24] Biologists are confronted with a hierarchy of organization comprised of self-organizing wholes nested within larger self-organizing wholes, which themselves are nested within still larger self-organizing wholes, and so on. Although Kant's organism concept, conceived as a natural end, serves as the crucial reference point in this scheme, its regulative status resists a direct correlation with any particular instances in nature itself – in contrast to the discursive, constitutive concepts of the understanding.

A critical consequence of this hierarchy of organized beings is that the *parts* of each of these self-organizing, functionally integrated wholes may themselves constitute self-organizing wholes at a different level from the wholes of which they are parts (Huneman 2014). This gives rise to a potential problem. In some such wholes, the relation between the parts may involve a degree of integration and cooperation so great that it threatens the identity of that whole in favour of the identity of a whole at a different level, typically below it. On evolutionary theories of biological individuality, this is referred to as the *lower-level selection problem*. This problem results from the competition between, and selection of, the individual organism's *parts* in a manner that weakens the capacity for competition and selection of the organism as a *whole*, in its interactions with other organismic wholes at its level (Queller and Strassmann 2009; Clarke 2013). This problem asserts itself, for example, in medical disorders that involve the aggressive replication of certain selfish cells that threaten rather than serve the interests of the biological organism of which they are parts. In such cases, the cells themselves become the units that are selected for, thereby achieving the status of 'biological individuals'.

Some biological individuals, however, possess effective mechanisms that *reduce* lower-level selection (within-organism selection) and thereby preserve the integrity of the whole at the higher level (the organism's own level). Biological phenomena that possess such mechanisms may thus be viewed as biological individuals to a greater degree than those that either lack such mechanisms or possess less effective mechanisms of this kind (Queller and Strassmann 2009; Clarke 2013). Clarke aptly refers to these as *individuating mechanisms*, which carry out *policing* and *demarcating* functions (Clarke 2013: 427). An example of such mechanisms is immunological activity, which Thomas Pradeu views as central for demarcating biological individuals. (I discuss Pradeu's position in greater detail in the next section.) The activity of these individuating mechanisms exhibits more clearly that biological individuality admits of degrees, since some biological entities manifest these policing and demarcating mechanisms to a greater or lesser extent than others (Clarke 2013).

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Clarke argues that *organisms* possess such mechanisms to an optimal degree. I claim that Kant's account of *reciprocal causality* captures the crucial feature attributed to such mechanisms. In the section that follows, I offer further evidence that the regulative concept of a biological whole is required for making sense of the activity of these individuating mechanisms.

5. Kantian wholes as epistemic grounds for the biological sciences

Strongly concurring with the view that the organism manifests the highest degree of biological individuality, Pradeu attempts to specify the individuating mechanisms responsible for this (Pradeu 2010: 248). He argues that, although selection also happens on other levels of the biological hierarchy, the entities on those other levels do not achieve the degree of cohesion and functional integration anywhere near as much as on the level of the organism. The reason is that only on the organism level do we find highly effective individuating mechanisms that carry out the requisite 'policing' activity that permits the organism to regulate the lower-level selection of its constituent parts. Pradeu maintains that 'the immune system constantly eliminates the replication of lower-level individuals' (Pradeu 2010: 264). It is through immune activity that 'selfish cell lineages', such as those that cause tumors, are eliminated (Pradeu 2010: 264). In this way, immune mechanisms function as individuating mechanisms in that they demarcate the identity of the biological individual in the very act of preserving it. Pradeu contends, however, that to determine what materials (endogenous or exogenous) count as *parts* of the organism, immune activity *presupposes a whole* that is constituted from a set of heterogeneous parts. The presupposition of a unified whole is thus vital for making sense of immune activity in organisms. Immunological activity would be unintelligible to us without the concept of the organism as a *whole*, the individuality of which it preserves.

Pradeu's account of immune function illustrates the usefulness of the organism concept, considered as a whole, not only for physiological individuality, as is typically acknowledged, but also for evolutionary individuality. Absent in Pradeu's account, however, is the acknowledgement of the regulative status of this concept. Thus, his project differs from Kant's, which views this whole as only guiding our judgement in the *identification* of biological individuals in the study of living nature, not as *explaining* the mechanisms at work in the empirical objects denoted by this concept – which is the task of the biologist. Notwithstanding their difference in programmes, Kant's insights lend support to Pradeu's agenda in that the systemic nature of immune activity requires the concept of the organism as a purposive *whole*, which Kant's theory supplies. The need for a concept of a purposive whole even in evolutionary accounts of biological individuality manifests the full range of application of Kant's general theory. Consequently, although the Kantian account of living nature explicitly exhibits features more readily associated with the physiological view of biological individuality, when fully expounded, it also provides support for the evolutionary view.

Philippe Huneman also claims a role for Kant's organism concept in evolutionary theory as he thinks it facilitates 'a synthesis of developmentalism and adaptationism', and consequently a unity between the *laws of form* – pertaining to physiological individuals, and the *laws of function* – governing species in evolutionary theory

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(Huneman 2017: 373). In fact, when considered in connection with an organism-focused strain of evolutionary theory, known in its most current form as the Extended Synthesis, 'Kant's understanding of organisms has been interpreted as a philosophical template' for merging the study of design and development in evolutionary theory (Gambarotto and Nahas 2022). Huneman argues that this synthesis is achieved through the two criteria of organismality that he thinks are operative in Kant's account. These are the *design criterion* (which serves the evolutionary view) and the *epigenesis criterion* (which serves the developmental view) (Huneman 2017). I maintain that this synthesis is further supported by recognizing that the laws of form of physiological individuality yield individuals whose functional integration, based on part/whole reciprocal causality, admits of varying degrees. This variation in degree of functional integration confers an evolutionary advantage on some biological individuals over others, depending on the capacity of the individual's parts to undergo lower-level selection.

Given this set of premises, it is reasonable to conclude that the degree to which the individual's parts are functionally integrated (an activity governed by the laws of form) is proportional to the degree to which the individual's parts do not engage in lower-level selection (an activity governed by the laws of function). This Huneman-inspired precept gains support from the conjunction of Clarke's and Pradeu's accounts. It is also consonant with Queller and Strassmann's (2009: 3144) claim that 'the essence of "organismality" lies in a shared purpose: the parts work together for the integrated whole, with high cooperation and very low conflict'.[25] On their view, 'the organism is the largest unit of near-unanimous design' (Queller and Strassmann 2009: 3144). This view puts the accent not on the 'capacity for selection' but on 'the capacity for adaptation' – the appearance of *goal-directedness* manifested by biological individuals, which distinguishes them from non-biological individuals (Queller and Strassmann 2009: 3144; Sterner 2015: 625). Notably, even Samir Okasha, though endorsing eliminativism concerning organisms, nonetheless acknowledges the usefulness of 'agential thinking' – which involves 'goal-directedness' and 'unity-of-purpose' – for guiding biological inquiry (Okasha 2018). Okasha cautions, however, against the move from applying agential thinking on the level of *evolved entities* to expanding it beyond that level and applying it to *natural selection itself*. While not identical to Kant's position, Okasha's view highlights concerns quite similar to Kant's.

These concerns, I maintain, are most effectively addressed by Kant's distinction between regulative and constitutive concepts, absent in current philosophy of biology. By recognizing the regulative status of concepts such as 'goal-directedness', 'design' and 'shared purpose', which fundamentally derive from the reflective judgement of the subject, we may resist the erroneous move of attributing these features to nature itself. Kant writes, 'the concept of a thing as in itself a natural end is ... for guiding research into objects of this kind and thinking over their highest ground in accordance with a remote analogy with our own causality in accordance with ends; not of course, for the sake of knowledge of nature or of its original ground' (*CJ*, 5: 375). Kant presses the point that this manner of conceiving of organisms is necessary for making sense of the scientific claims we want to make about them, not as claims about the organisms themselves. The appeal of a Kantian account of living nature is that it offers maximal epistemic grounding with minimal ontological commitment.

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This framework paves the way for viewing some organic beings as natural ends in a stronger sense than others, depending on the degree of functional integration and cohesion we detect in their parts. Although organisms tend to exhibit these features to the highest degree, they are also manifested by other non-organismic beings at different levels of the biological hierarchy, both as parts of organisms, for example, genes and cells, and as groups of organisms, for example, holobionts and ecosystems. At each of these levels, reflective judgement requires us to represent the integration and cohesion of the parts as individual biological *wholes*. This multiple realizability of biological individuality is, as I have argued, epistemically grounded in Kant's account of the reciprocal causality of the parts of biological beings – which fundamentally requires the concept of a biological, individual whole, considered as a *natural end.* Kant's aim is to make us recognize that the concept of this whole as a purposive, self-organizing being, a natural end, can only serve its function *as* a concept in the judgement of the subject, not as pulsating in the veins of nature itself (*CJ,* 5: 375–6).

Consequently, empirical wholes of various kinds, and at various biological levels, may count as biological individuals, depending on the degree to which their functionally integrated parts are *represented* as a natural end. This requires more than a merely mechanistic account of the integration of their parts. It requires a teleological judgement (in a regulative sense) on the part of the reflecting subject, such that the mechanically integrated parts are viewed as *organs* in a naturally organized whole. 'The organization of organisms cannot be experienced as something that is actual' (Onnasch 2014). It is fundamentally a ground for making judgements about living nature in a manner that permits a scientific inquiry of it, without ontologically inflating or deflating the objects of that inquiry.[26]

6. Conclusion

As the above analysis reveals, Kant's position can successfully accommodate the extensive range of biological individuals acknowledged by contemporary biologists. Though Kant's account of natural ends explicitly only acknowledges organisms, his views may be extended to other biological phenomena, since it is not *organismality* but rather the functional integration arising from the reciprocal causality and self-organization of biological phenomena that serves as his criterion of biological individuality. Since this functional integration admits of various forms and degrees, and appears on many levels of biological organization, Kant's position provides support for the widely accepted pluralist account of biological individuality for addressing the multiple realizability problem on an empirical level. At the same time, it also provides the grounds for a monist view of biological individuality on an epistemic level, in that it specifies the common principle that applies to our concepts of *all* these biological individuals – the reciprocal causality that necessitates the regulative concept of a *whole,* which proceeds from the reflecting power of judgement (*CJ,* 5: 375–6). While the parts contributing to the form and function of a biological individual must be studied empirically among the *objects in* living nature, considered as a *whole* – and thus as a natural end – a biological individual is a *representation of* living nature that makes sense of the science we use to understand it.

These considerations may lead us to ask: what impact do the judgements we impose on nature have on biology as a science and how biologists *do* their science?

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My conclusions imply that the search for a single, all-encompassing characterization of biological individuality is futile on an empirical level. Biologists simply have to navigate the various areas of their discipline adopting a pluralist approach, in which the relevant concept of biological individuality is significantly circumscribed by the specific aims and contexts of their inquiry. A monist account of biological individuality is only available on an epistemic level, and best explicated by Kant's account of the part/whole relation in our judgements of living nature. This epistemic foundation, however, provides a crucial focal point that prevents the plethora of empirical notions of biological individuality from being completely arbitrary, as it limits the biologist's domain to the instances in living nature that manifest the unique part/whole relation of *reciprocal causality* exhibited by natural ends. A Kantian account of biological individuality identifies the regulative concept that grounds the approach of biologists in their investigation of the complex expanse of living nature.

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Notes

1 References to Kant's works indicate the title abbreviation, volume and page number of the *Akademie-Ausgabe*. Quotations are taken from the English translation in The Cambridge Edition of the Works of Immanuel Kant, edited by Paul Guyer and Allen Wood. The abbreviations used for Kant's texts are *CJ* = *Critique of the Power of Judgement*, FI = First Introduction to the *Critique of the Power of Judgement*, *OP* = *Opus Postumum*, *MFNS* = *Metaphysical Foundations of Natural Science*.

2 Defending *microbialism*, Dupré and O'Malley (2009) argue that ground-level organisms constitute only a small fraction of biological individuals and are thus marginal in comparison with microbes.

3 Even the long-standing genome-based view is inadequate in the case of complex collective organisms such as coral reefs, biofilms and slime moulds (Folse and Roughgarden 2010).

4 Cited in Huneman (2010: 344).

5 An even more complicating factor is that 'many evolutionary individuals – including genes, lineages, clades, and perhaps viruses – are not themselves living things' (Wilson and Barker 2019: 9).

6 Clarke (2013: 413–14) insists that 'the organism is the entity that a population biologist counts', while Godfrey-Smith (2013) contends that it is 'Darwinian individuals' (units of selection).

7 Sterner (2015: 610) argues that Clarke's functionalist approach needs to be supplemented with the material elements of Godfrey-Smith's pluralist stance: 'a bottleneck in development, a reproductive division of labor between germ line and body, and physiological integration'.

8 For a treatment of the broader historical context in which Kant developed his views on natural science see Massimi (2009).

9 See Rieppel (2013) and Haber (2016) for further discussions of the distinction between mereological part/whole relations and set-membership relations in biological entities.

10 See Breitenbach (2017) for a more thorough treatment of the unique role of biological laws in Kant's conception of the unity of nature.

11 'Communication' between the parts of organisms that contribute to their structure, function and integration is currently a topic of much interest (Reynolds 2017: 109–28).

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12 Mossio et al. (2016) stress that the organization exhibited by organisms undergoes *variation*, and that both organization and its variation taken together constitute the distinguishing features of organisms.
13 Teufel (2011: 255–7) examines the difficulties associated with whole-to-part causality.
14 In backwards causality, the whole that causes its parts is something that will exist in the future rather than something that exists prior to the parts – which is paradoxical. See van den Berg (2014: 57–75) for a broader, historical account of part/whole relations in the Wolffian tradition, and how Kant departs from that tradition in his views on mechanical explanation.
15 Kant's account specifies the central ideas that facilitate the *identification* of biological individuals; but this does not amount to an *explanation* of them (*CJ*, 5: 411; Beekman and Jochemsen 2022: 6).
16 Cooper (2020) contends that Kant's characterization of natural purposiveness as 'a designer's intention' is inadequate to explain its power as a natural cause, and that Hegel offers a more robust account.
17 See Massimi (2009) for a more extensive treatment than is possible within the scope of this article of Kant's distinction between regulative and constitutive ideas and their use in natural science. Of particular interest is the dismantling of this distinction by the *Naturphilosophen* of the nineteenth century.
18 For a closer look at Kant's critique of teleology in biological inquiry see McLaughlin (1990), Zammito (2003) and Quarfood (2006).
19 See Teufel (2011) for a critique of realist views of teleology in philosophy of biology.
20 Breitenbach (2013: 24) provides a strong defence of this interpretation: 'Our analogical reflection about living nature ... has not only heuristic import but also a necessary role in our very thinking about the "form" and "internal possibility" of living nature'.
21 The passages from the *OP* in this section are translated by Toepfer and cited in Toepfer (2019).
22 See van den Berg (2014: 130–3) for a helpful treatment of Buffon's influence on Kant's species concept.
23 See Rieppel (2013) for further discussion on species as individuals.
24 The notions of 'species as individuals' and 'species selection' are long-standing contentious issues (Folse and Roughgarden 2010: 464).
25 Cited in Reynolds (2017: 117).
26 An anonymous reviewer suggests that this Kantian deflationary approach may also be helpful in addressing the 'demarcation problem' in attempts to naturalize teleology.

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