

Kant, Linnaeus, and the Economy of Nature

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**** Please cite the version of record (2020) published in *Studies in History and Philosophy of Biology & Biomedical Sciences* doi:10.1016/j.shpsc.2020.101294**

Abstract: *Ecology arguably has roots in eighteenth-century natural histories, such as Linnaeus's economy of nature, which pressed a case for holistic and final-causal explanations of organisms in terms of what we'd now call their environment. After sketching Kant's arguments for the indispensability of final-causal explanation merely in the case of individual organisms, and considering the Linnaean alternative, this paper examines Kant's critical response to Linnaean ideas. I argue that Kant does not explicitly reject Linnaeus's holism. But he maintains that the indispensability of final-causal explanation depends on robust modal connections between types of organism and their functional parts; relationships in Linnaeus's economy of nature, by contrast, are relatively contingent. Kant's framework avoids strong metaphysical assumptions, is responsive to empirical evidence, and can be fruitfully compared with some contemporary approaches to biological organization.*

One consequence of eighteenth-century projects in natural history was greater attention to connections between individual organisms and what we now call their environment. Not only do organisms act on their environment, they are acted on by it. If so, long-standing assumptions about the special explanatory status of organisms would need to be revised. Carl Linnaeus went about doing so in a highly systematic way

through his conception of an *economy of nature*, which was at partly grounded on acute empirical observation of the dynamics of living populations and communities. By fulfilling its proper role or station, Linnaeus held, a population of a given species is functional or beneficial in several respects: for other populations, for the development and stability of local communities or ecosystems, and even for nature as a whole. As Lisbet Rausing (2003, 188) summarizes, Linnaeus's economy of nature

meant that nature was a supra-organismic being, existing in a self-regulating state of homeostasis...this refashioned teleology in turn engendered an interest in what we now consider feedback-governed equilibria: population checks, reproduction rates, predator-prey relations, food chains, species interdependence and competition, plant succession, parasitism, and hydraulic cycles.

Thus his economy of nature involved both explanatory holism and an ambitious teleological system.

But not all were convinced. Here I lay out Kant's critical discussion of Linnaean ideas, which has received comparatively little attention so far. In his *Critique of the Power of Judgment*, Kant endorses an indispensable role for non-mechanistic, final-causal explanation in the case of organisms. He then faces the question whether final-causal explanation is also indispensable for larger groups.

As I show, Kant's rejection of this Linnaean conclusion does not turn on worries about holism as such (that is, about invoking wholes in explanations of their parts). Instead, Kant stresses that the functional parts of organisms play a specific or even unique role, whereas relationships between species are loose and contingent. Kant appears willing, nevertheless, to blur this distinction in the face of examples such as grafting and

self-repair in plants. I suggest that that this can be seen as a strength of his position, and conclude by suggesting ways in which this Kantian position and contemporary debates about ecology and related fields can be mutually informative.

I. Kant on Final Causes and the Explanation of Organisms

This section lays out some basic aspects of Kant's account of final causes in natural science. I first introduce Kant's controversial claim that organisms cannot be explained merely mechanistically. I then consider the indispensable role he takes final causality, specifically, to play in the explanation of organisms. Finally, I lay out his distinction between organisms as so-called internal purposes, and the external or relative purposiveness that could be attributed to species or communities. This distinction is relevant because Kant's remarks on Linnaeus are part of an argument that final causality need not play a role in explaining merely relative purposiveness.

I.1 The Limits of Mechanistic Explanation

In the third *Critique*, Kant leaves key questions open about the fundamental metaphysical status of organisms.¹ He focuses instead on the immanent explanatory presuppositions

¹ See Kant (1910-) vol. 5, p. 415-16: "it can be assumed that nature is completely possible in accordance with both of the universally consonant laws (the physical laws and those of final causes), although we can have no insight at all into the way in which this happens..." All subsequent references to Kant's texts are to this Akademie edition by volume number and page number, except for the *Critique of Pure Reason*, which is cited by the standard A/B pagination. I have used the Cambridge translations of Kant's works.

² See 5, 400: "it would be absurd for humans to hope that there may arise a Newton who could make comprehensible [*begreiflich*] even the generation

of the life sciences. This is not to say he simply describes the life sciences as they currently exist. Instead, he makes assertions about unchanging conditions on scientific inquiry into organisms, which are determined by the basic features of finite intellects like ours; he concludes that we will *never* be able to explain living beings in solely mechanistic terms.²

What does Kant mean by mechanistic explanation? As several commentators have stressed, mechanism should not be taken too broadly – as encompassing efficient causality or empirical scientific laws as such.³ On the other hand, Kant is not just concerned with refuting a narrowly mechanistic or Cartesian program in empirical physics, which would reduce all phenomena to the transmission of motion by contact. Kant says quite a bit about mechanism; I'll first introduce a *necessary* condition he places on merely mechanistic explanation. If a whole is to be explained mechanistically, it must be explicable in terms of the separable properties of its spatial parts:

If we consider a material whole, as far as its form is concerned, as a product of the parts and of their forces and of their capacity to combine by themselves (including as parts other material that they add to themselves), then we represent a mechanical kind of generation. (5, 408; cf. 5, 409; 5, 412; 5, 420–21)

of a blade of grass according to natural laws..."; cf. 5, 409. This does not imply that organisms are intrinsically immaterial or endowed with special vital forces. For this claim is restricted to a certain kind of cognizer, though we should be cautious in taking "humans" here to refer only to our actual biological species. On the importance here of discursive intellectual capacities (which need not be merely human) see Breitenbach (2008, 357), Förster (2012, 142), McLaughlin (2014, 158–164), and Quarfood (2014).

³ See McLaughlin (1990), McLaughlin (2014), and Breitenbach (2009).

This kind of explanation is basically additive: larger-scale phenomena are explained by combining the properties of smaller-scale phenomena.

For Kant, this necessary condition for merely mechanistic explanation is not met in the case of organisms and their functional parts. These parts must instead be explained in terms of their “relation to the whole” (5, 373). For example, Kant considers the relationship between a tree and one of its leaves (5, 372). The persistence of the leaf across time must be explained in terms of the rest of the tree and thus, he suggests, by properties of the tree as a whole.

A second non-mechanistic feature of organisms Kant lays out is that they involve relations of reciprocal determination between the “form” of the organism and its parts (5, 373). To return to the example of the tree, each leaf contributes causally to the persistence of the tree’s “form”: “the leaves are certainly products of the tree, yet they preserve it in turn, for repeated defoliation would kill it, and its growth depends on their effects on the stem” (5, 372).⁴ The forms of artifacts, by contrast, are determined by something “outside of” them, as when the form of a watch is actively determined by a watchmaker (5, 374).

⁴ Ginsborg (2015, 303) argues that Kant is committed to a further inexplicability claim: that “we cannot explain how the sorts of regularities characteristic of organisms come to hold simply in virtue of the powers of matter *tout court*.” It seems plausible that for Kant, we cannot in fact explain living beings with the resources of general physics alone. But it is less clear that this constitutes a special problem for the life sciences (compare Maupertuis (1754), a work Kant owned in translation). Since this sort of inexplicability is not explicitly invoked in Kant’s discussion of relative purposiveness, I leave it aside in this paper.

While interdependence between parts and wholes is fairly straightforward, at least as an explanatory thesis that need not have strong metaphysical implications, it is less clear how to understand the implications of Kant’s appeal to “form” here. Some interpreters take Kant to base the distinctive status of organisms directly in an *inner form* or *good of their own*.⁵ While some of Kant’s texts do suggest this, it would be worrisome if Kant took a concept like inner form to play a fundamental or primitive role in his account.⁶ The empirical criteria for identifying instances of such concepts are not self-evident. So the mere appeal to an inner form or good is open to a more holistically inclined thinker’s objection that species or even larger groups *also* have an inner form or good of their own, just as individual organisms do. It is more charitable, I’d suggest, to read the account of inner form or intrinsic good in Kant as partly defined in terms of other aspects of his account of purposiveness. Below, I’ll argue that Kant’s distinction between internal and external purposiveness can help in understanding his references to form in a more concrete way.

1.2 *The Need for Final-Causal Explanation*

Let us turn to Kant’s claim that final causes are in some sense indispensable for the explanation of organisms: the

⁵ Breitenbach (2009, 135–7) appeals to the “inner form” of organisms. McLaughlin (2001, 191–94; 200–4) refers to the “good of [living beings’] own,” ultimately grounded in their Aristotelian function or *ergon*.

⁶ Some commentators suggest Kant accepts an eternalist and essentialist notion of biological species (e.g. Zammito (1992, 216–217), and compare A317–18/B374–75)). Such a species concept could somehow ground the inner form of organisms. But even if Kant does have a view of species that could do this sort of work (which is unclear, cf. 8, 62–3), he does not always individuate final-causal explanations in terms of species, as when he famously considers the role of lenses in eyes (20, 236; cf. Herz (1788)). Such an explanation concerns a type of structure many species share.

concept of a final cause is no mere convenience that could eventually be replaced by a mechanistic account.⁷ As Hannah Ginsborg (2015, 255) has noted, the merely mechanistic inexplicability of organisms is a basically negative thesis, which does not establish the positive claim that final causality in particular *is* of use here, let alone that it is indispensable. One might instead conclude that organisms are just inexplicable, or that they can be explained in some other way that is neither mechanistic nor final-causal.

Consider an example: Kant's third *Critique* discusses pantheists, who are understood as taking the whole universe to explain or ground the particular things it contains as parts. The universe, on the pantheist's account, is not explained by the separate properties of its spatial parts. So, according to Kant's criterion, it cannot be explained mechanistically. But it is far from obvious that the pantheist position must instead invoke final causes.⁸ What this example brings out is that a sufficient condition for non-mechanistic explanation need not be a sufficient condition for explanation that involves final causes. There is a possibility, then, that Kant identifies further conditions for final-causal explanation; I elaborate on this possibility below.

⁷ See especially 5, 398. Some commentators do suggest that, for Kant, final causality is dispensable: see Mayr (1992, 121), Guyer (2003, 15), and Walsh (2006). Against such readings, see e.g. Breitenbach (2009), Toepfer (2012), and Ginsborg (2015).

⁸ For Kant's discussion of pantheism, see 5, 439–440. Many post-Kantian thinkers integrated his ideas on teleology into a holistic conception of nature that could be seen as a form of pantheism: see e.g. Schelling (2004), and for discussion of these schools of thought more generally Gloy & Burger (1993) and Reill (2005).

⁹ Kant holds that the principle of teleological judgment allows us to consider “things in nature...in accordance with a new, lawful order, and [to extend]

Leaving aside the full justification of Kant's indispensability claim, let us consider how it is to be understood. We can distinguish at least two readings of it, depending on what ineliminable role Kant takes final causes to play in explaining organisms. First, final-causal claims may be indispensable because they themselves are necessary *and* sufficient to explain features of organisms.⁹ On a second, weaker reading, final-causal claims would merely enable explanations of organisms: they would be necessary, but *not* sufficient conditions. Instead, as has been proposed in the recent literature, final causes could be required to adequately describe organisms, or to initially identify living beings and their functional parts.¹⁰ In this paper, I remain neutral on whether Kant thinks final-causal propositions are independently explanatory. In what follows, the phrase ‘final-causal explanation’ will refer to any explanation for which final-causal propositions are a necessary condition.

1.3 *Internal and External Purposiveness*

Finally, let us consider Kant's distinction between internal and external purposiveness in greater detail. To begin with some examples: Kant holds that organisms such as a tree exhibit internal purposiveness. A watch, like other artifacts,

natural science in accordance with another principle, namely that of final causes” (5, 379). If, in turn, “inferences” could be drawn from these “given laws to conclusions,” then final-causal laws would be genuinely explanatory (5, 175). Kant suggests, however, that no informative inferences of this sort are within reach for us (5, 412).

¹⁰ A merely descriptive role is suggested by the following remark: “positing ends of nature in its products, insofar as it constitutes a system in accordance with teleological concepts, belongs only to the description of nature...” (5, 417; cf. 5, 411–12); see also McLaughlin (2014, 154). Van den Berg (2014) and Breitenbach (2017) propose an identificatory role for final-causal claims in Kant.

exhibits external or relative purposiveness, but we will see that there are apparent cases of external purposiveness in the natural world, as well.

Purposiveness in the most general sense is “the causality of a *concept* with regard to its *object*” (5, 220). Kant then introduces a number of distinctions within purposiveness in general.¹¹ He defines internal purposiveness as “grounded...on the internal possibility of the object,” and external purposiveness as grounded “on the relative possibility of its external consequences,” specifically “its correspondence to an end that lies in other things,” or “in the contingent *use* of it” (20, 249; cf. 5, 366–67). In turn, Kant holds that merely relative or external purposiveness “justifies no absolute teleological judgments” (5, 369). One way of interpreting this claim is in terms of the notion of indispensability raised earlier in this section: cases of merely external purposiveness can be explained without reference to final causes. There is textual support for this interpretation: whereas it is “indispensable” to our explanations to regard organisms and their functional parts in terms of final-causal “analogy,” Kant writes that outside of the domain of organisms, this analogical approach is at most “useful, but not indispensable” (5, 398).

While the internal-external distinction is fairly abstract, it seems to play an important role in supporting Kant’s claim that organisms and their functional parts specifically require final-causal explanation. In particular, it will help Kant provide informative criteria for characterizing what is distinctive about organisms, and why they require a special sort of explanation.

I will discuss applications of the internal-external distinction at greater length below; at this point, I simply note four key features of the distinction, and caution against some apparently intuitive ways of interpreting it. First, Kant is apparently drawing a distinction in modal terms: the internal possibility of a thing is distinguished from how it is *contingently* used. Second, he suggests that external purposes are means to ends: if something is externally purposive, it “exists...not as a final end, but necessarily at the same time as a means” (5, 426). Third, as the name implies, external purposiveness specifically pertains to “external relations” — and, fourth, one of the relata is an “organized” being (5, 425). By contrast, the relationship between (for example) two geological processes does not manifest external purposiveness.

Some readers have proposed focusing on the means-ends structure of external purposiveness, noting that relationships between means and ends form indefinite series.¹² Kant considers, for instance, how camels use desert plants as a means to survive, and there is also a sense in which the plants ‘use’ the dry conditions and alkaline soils to thrive.¹³ Kant in turn denies that soil and dry weather exist for the sake of plants or camels.

But the existence of a series of means-ends relations is not a sufficient condition for external purposiveness. Individual organisms contain means-ends relations among their own functional parts, and Kant ultimately denies that we can assume that even the well-being of an organism is a final end in an unqualified sense.¹⁴ Moreover, while it might seem obvious to us that, for example, succulents do not exist for the sake of

¹¹ Marc-Wogau (1938) helpfully surveys Kant’s numerous distinctions among kinds of purposiveness.

¹² See McLaughlin (2001, pp. 19-20) and Gayon (2013).

¹³ See 5, 367–8. More precisely, few other plant species can survive in such dry conditions and soil, so these features of the environment indirectly benefit desert plants by reducing competition (cf. Breitenbach (2009, 136)).

¹⁴ See 5, 426.

camels, Linnaeus does endorse precisely this counterintuitive claim. And he holds that populations and species play a role in the collective well-being of nature as a whole while also depending on it, just as organs stand in reciprocal dependence relations with organisms. So rather than rely on our judgements about the intuitive plausibility of Kant's position, we should examine the details of how he argues against Linnaeus.

The phrase 'external purposiveness' might suggest that Kant has in mind any purposive relationships beyond the spatial boundaries of an individual organism's body. Kant does not seem to rest his distinction on this spatial basis, however, or on a prior account of what individuates organisms. For example, in sexual reproduction two individuals of the same species jointly constitute what he calls an organizing whole that manifests *internal* purposiveness:

[In the case of] the organization of the two sexes in relation to one another for the propagation of their kind...one can always ask, just as in the case of an individual, why must such a pair have existed? The answer is that this is what here first constitutes an *organizing* whole, although not one that is organized in a single body. (5, 425)

For Kant, then, two individual organisms can jointly constitute a whole that requires final-causal explanation. So the distinction between internal and external purposiveness is not a merely spatial one, based on the boundaries of "a single body." Below, I'll consider in further detail precisely *why* Kant regards two individuals as an organizing whole that requires final-causal explanation.

Though this sketch of Kant's views on the explanation of organisms is far from complete, it should indicate possible motivations for his discussion of Linnaeus's economy of nature. Kant holds that merely mechanistic explanation fails in the case of organisms: some properties of organisms' parts must be explained by reference to properties of organisms as wholes. And Kant holds, further, that final-causal claims are indispensable for explaining organisms. As I'll explore in the following section, Linnaeus contends that some properties of organisms must be explained by reference to populations, communities, and a general economy of nature. This suffices to show that explanation in these contexts is not merely mechanistic, according to Kant's definition above. Kant does not take final-causal claims to be indispensable for explaining populations or communities, however — let alone nature as a whole. Kant's justification for this, I'll argue in section 3, turns on his distinction between internal and external purposiveness.

2. *Linnaeus on the Economy of Nature and the Explanation of Organisms*

I now turn to Linnaeus. First, I defend reading him as pursuing causal explanations, rather than as seeking a purely descriptive taxonomy. Then, I very briefly sketch Linnaeus's account of the 'economy of nature,' giving some examples of how he uses this framework to holistically explain the features of organisms. Finally, I provide some historical justification for reading Kant as responding to Linnaeus's ideas.

Linnaeus is sometimes portrayed as primarily classifying living beings in a merely descriptive and somewhat arbitrary way.¹⁵ Kant himself, in lectures on geography, reportedly

¹⁵ See e.g. Worster (1977, 32), Farber (2000, 7), and Gaukroger (2010, 194–95). Foucault (1989) defends a version of this reading: Linnaeus's goal is a

"*taxonomia universalis*...the project of discovering in all the concrete domains of nature or society the same distributions and the same order"

advanced such a view of Linnaeus.¹⁶ More broadly, Kant holds that science proper studies the real “interconnection” among objects – that is, causation and other real conditioning relations (4, 468).¹⁷ By contrast, a descriptive classification may be motivated by pragmatic considerations, such as ease of identification. Compare, for instance, a description of the distinctive colorful plumage of a male peacock, which makes it readily identifiable, with an account of the development of the plumage, or of its function in the selection of a mate. Descriptive claims of this kind may abstract entirely from the causal features of phenomena. So if Linnaeus’s project were purely descriptive, it would seem to have little to do with the science of living beings as conceived by Kant.

Modern scholarship on Linnaeus has established that his work includes much more than merely descriptive taxonomy.¹⁸ Even his taxonomical works make reference to causal criteria (e.g., Linnaeus (1798, 20–23)). And Linnaeus’s work on the economy of nature plainly advances (final-)causal claims about organisms and species, purportedly on the basis of empirical evidence. It is this body of work that is most relevant for Kant’s discussion in the third *Critique*. In fact, Kant does not simply dismiss the economy of nature as a descriptive or classificatory project.

(84; see also 137). While there may be some truth to this characterization, Foucault’s suggestion that the Linnaean project is unrelated to attempts at *causal* explanation in comparative anatomy or early “biology” is not borne out by Linnaeus’s writings (1989, xxiv).

¹⁶ Kant reportedly claimed that Linnaeus’s divisions between species are merely “logical” or made “in my head” (9, 159). Similar criticisms of Linnaeus were made by Buffon: see Sloan (1976) and (2006). In a 1785 essay, however, Kant appears to regard Linnaeus’s classification of plant reproductive organs as based in causal, not merely descriptive, analysis (8, 161).

¹⁷ On Kant’s notion of a real conditioning relation, see Watkins (2018).

Let us turn to Linnaeus’s conception of the economy of nature itself, chiefly sketched in *Oeconomia Naturae* (ON) (1749), *Cui Bono* (1752), and *Politia Naturae* (PN) (1760). These works defend the basic idea that species¹⁹ exist for each other’s benefit, and thereby accomplish “general ends” instituted by their creator ((1762) [ON§1; cf. §20]). As might be expected, not all of Linnaeus’s support for this theory is strictly empirical. In particular, the idea of an economy of nature has a normative dimension: relations between populations and species are globally beneficial, such that nature as a whole “profit[s]” by them (Linnaeus (1972), p. 117 [PN II.6]). At times, Linnaeus seems committed to the stronger claim that the actual economy of nature involves the best overall outcomes for each species as well as globally.²⁰

Yet Linnaeus takes this view of the cosmos to be, in part, an extrapolation from empirical accounts of natural phenomena. He considers a wide range of examples, but I will begin by focusing on three helpful cases he discusses.²¹ We will return to two of them, which also appear in Kant’s third *Critique*, at length in section 3.

First, Linnaeus asserts that winter snow is beneficial for plants because it insulates roots and seeds from the cold, and

¹⁸ See generally Larson (1971), Müller-Wille (1999), Rausing (2003), Winsor (2003), Winsor (2006), and Wille (2015, 646–47). For examples of Linnaean causal hypotheses in a medical context, as well as Linnaean speculation on the natural origins of life, see Antonovics and Kitzinger (2016).

¹⁹ In what follows, I refer to ‘species’ in a loose sense: Linnaeus’s empirical cases typically concern local, interacting *populations* of species, but Linnaeus himself does not always observe this distinction.

²⁰ See Linnaeus (1972), p. 104 [PN I.Pref.]; Linnaeus (1793, 4). On the complex status of humans in the economy of nature, see e.g. Linnaeus (1972, 121 [PN I.21]) and Rausing (2003, 190–91).

²¹ For other examples and quotations, see Egerton (2007).

that this in some sense explains *why* there is snow in winter.²² He takes these environmental factors to be part of the economy of nature, constraining species but also creating incentives or “advantages” – on Linnaeus’s economic analogy – for individuals to carry out their proper “functions” in the system (Linnaeus (1972), p. 117-8 [PN II.6-7]). In some cases, Linnaeus contends, these advantages are so fine-tuned to a particular species that the species resists invasion by nearly any competitor. So Linnaeus’s economy of nature is not merely driven by general incentives, but assigns particular “stations” or functions to species, as highlighted by his metaphor of a police of nature.²³

Another example is the relationship between predators and prey. The outcomes for an individual in a prey species, Linnaeus suggests, often must be explained with reference to the size of the nearby population competing with it for resources. Too much competition has an adverse effect on the individual. So to explain outcomes for an individual, one must refer to the size of a whole population: if there are more predators, the size of the prey population will likely diminish, reducing competition for resources.²⁴ Thus, somewhat counterintuitively, the existence of predators is good for the prey population on the whole (if not for the individuals that are preyed upon).

A third example Linnaeus considers is the transition from one kind of living community to another: specifically, of a

marsh to a meadow.²⁵ Meadow plants are not suited to environments with too much standing water. The prior presence of other species — Linnaeus mentions sphagnum moss — can reduce the amount of standing water, and by decomposing create a stable substrate for the roots of meadow plants. Thus, the likelihood of a given individual meadow plant flourishing in this community will be higher if sphagnum moss has been present.²⁶

Based on examples like these, Linnaeus endorses what I’ll call a *parity of explanation* principle: the explanatory status of the ‘economy of nature’ is comparable to that of organisms, even though the economy of nature as Linnaeus conceives it seems to include non-living as well as living elements. Thus Linnaeus, for example, contends that a certain moth species as a whole is “formed, *in order to keep a due proportion*” between the grass species its larvae prey on and other plant species (Linnaeus (1762), p. 76 [ON §9]; emphasis added). To return to an example we saw Kant discuss in section 1.3, Linnaeus holds that “nature has placed the succulent plants on rocks and the driest hills” not just to benefit animals such as camels, but also to improve soil quality more generally (Linnaeus (1762, p. 81; cf. p. 97)). Both the existence and the characteristic features of the moth or succulent species must be explained by reference to ends, on this view. Furthermore, Linnaeus claims that as in human economies, nature observes a division of labor, such that

²² See *Oeconomia Naturae*, §2 (Linnaeus (1762, 47)).

²³ Linnaeus refers to stations at e.g. (1972, 106-7) [PN I.3]. Pearce (2010) defends the influence of Linnaeus’s conception of station (and his attention to non-living environmental factors) on de Candolle, Lyell, and Darwin.

²⁴ See e.g. ON §1 and §9 (Linnaeus (1762, 39ff. and 72ff.)).

²⁵ Later ecologists such as Henry Chandler Cowles would call this a case of plant *succession*. Note that whereas in more recent ecology the term

‘community’ is used to refer specifically to the living components of ecosystems, Linnaeus did not appear to draw this distinction. Yet is noteworthy in the history of ecology in part because of his attention to non-living factors, even if he did not theorize about them in the systematic and quantitative way that became prevalent in the nineteenth century.

²⁶ See ON §2 (Linnaeus (1762, p. 44-5)).

each species has a *specific* or even unique “function,” rather than a great number of them (Linnaeus (1972, 118 [PN II.7]).

Before turning to Kant’s views, we should consider a historical question: to what extent can Kant be seen as responding to Linnaeus in the third *Critique*? Strikingly, Linnaeus is the only thinker Kant names in his discussion of relative or external purposiveness. In an earlier scientific essay, he discusses the economy of nature in some detail, and makes numerous references to Linnaeus elsewhere.²⁷ Furthermore, Kant critically discusses several of the very same examples that appear in Linnaeus: snow protecting seeds from frost, the relationship between camels and desert plants, and relations between grazing mammals and the plants they prey upon.

More broadly, Kant focuses on empirical support for the final-causal explanation of communities and other groups. This empirical project is pursued in much greater detail by Linnaeus than by other teleologists of the period, such as Christian Wolff. Linnaeus is also, unlike Wolff and his followers, relatively non-anthropocentric.²⁸ Linnaeus and Kant seem to agree that, since human beings can flexibly “adapt for [our] own use all that is superfluous” in the rest of living nature, studying humans may not be a good way to assess whether there are stable relations of external natural purposiveness (Linnaeus (1972), p. 116 [PN I.35]; cf. Kant (5, 368)). Finally, Linnaeus’s economy of nature is a sophisticated holistic alternative to Kant’s account, and threatens to undermine Kant’s claim that organisms have a

²⁷ See 1, 198; compare, on the economy of nature, 1, 212; 1, 317; 1, 458 and 7, 310. Other references to Linnaeus can be found at 2, 8; 7, 184; 7, 322–23; 8, 162; 8, 164(n.); 9, 204, 9, 250; 9, 303; 15, 885; 25, 672; 25, 675; and 25, 1415. The most widely discussed reference to Linnaeus in Kant’s writings is in the unpublished First Introduction to the third *Critique*, at 20, 216 (n.): for discussion see e.g. Allison (2001, 13–42), Marcucci (2001), and Cooper (2017).

special explanatory status, so it is also charitable to read Kant as taking Linnaean ideas seriously.

We cannot assume, however, that Kant was familiar with the details of Linnaeus’s texts, as opposed to his general ideas and arguments.²⁹ I do not claim that Kant’s arguments are exclusively directed at Linnaeus — especially when Kant discusses natural features which are apparently beneficial to humans (which are stressed in the teleological theories of Wolff and other authors). But Kant’s arguments do apply to Linnaeus’s position and address specific examples Linnaeus uses to support it.

3. *Kant on Linnaeus’s Economy of Nature*

In this section, I return to Kant’s contention that for explaining the features of natural groups — such as populations and communities — final causal claims are not indispensable, but at most useful. First, I lay out Kant’s views on two proposals suggested by examples that both he and Linnaeus discuss: (1) that beneficial features in the non-living environment require final-causal explanation and (2) that advantageous relations among living populations, such as between predator and prey species, require final-causal treatment. I then consider (3) how Kant’s treatment of these examples helps us better understand his views on the indispensability of final-causal claims.

²⁸ For an overview of Wolff’s views, see Beck (1969, 256–275). Kant does take note of anthropocentric teleological views (on which “the human being...is the ultimate end of the creation here on earth”) as representing “the apparently opposite path” from Linnaeus’s system (5, 426–27).

²⁹ Kant’s library at his death is not known to contain any works by Linnaeus: see Warda (1922).

Before turning to details, let me note some possible Kantian objections to Linnaeus that I will *not* be considering. In section 2, we saw that Linnaeus's views rely on economic and political metaphors, and that he draws very general conclusions on this basis. For instance, invoking older ideas of a balance of nature, he holds that all interspecies relations are profitable to the populations involved.³⁰ There are various resources in Kant's writings to challenge such a generalization, but he doesn't do so explicitly in the third *Critique*. Linnaeus also emphasizes the theological implications of his work, as when he refers to an "empire of nature" governed by a divine "sovereign" and "artisan," and assumes that specific relations in the economy of nature can be unproblematically traced to divine design (Linnaeus (1793, 1-2; 9-10)). Such claims would presumably be subject to Kant's critique of 'physico-theology,' but I focus on his assessment of the empirical basis for systems of relative purposiveness, including Linnaeus's economy of nature.³¹

3.1 *Benefits from the Non-Living Environment*

Above, we saw Linnaeus consider how plants seem to benefit from snow, which protects their seeds from frost. Kant considers this and a number of other benefits from the arctic environment:

In cold lands the snow protects the seeds from frost; it facilitates communication among humans (by means of sleds); the Laplanders find animals there that bring about this communication (reindeer), which find adequate nourishment in a sparse moss, which they must even scrape out from under the snow, and yet are easily tamed and readily deprived of the freedom in which they could otherwise maintain themselves quite well. For other peoples in the same icy regions the sea contains a rich supply of animals which, even beyond the nourishment and clothing that they provide and the wood which the sea as it were washes up for them for houses, also supplies them with fuel for warming their huts. Now here is an admirable confluence of so many relations of nature for one end...But one does not see why human beings have to live there at all...For even if all of this natural usefulness did not exist, we would find nothing lacking in this state of things for the adequacy of natural causes. (5, 369)

Kant's fundamental objection, which appears near the end of the passage, is that the various benefits mentioned depend on the contingent presence of organisms in arctic lands. We can conceive that these areas were never inhabited by plants at all.³² If that were the case, there could still be an adequate scientific

³⁰ See Lovejoy (1936) and Egerton (1973).

³¹ On appeals to divine design, see e.g. 5, 438 and 5, 440. While Kant allows for pragmatically oriented reflection on the apparent purposiveness of nature for humans – for instance, the hypothesis that fleas are an "incentive" for human hygiene – he describes such hypotheses as merely "entertaining" or prudentially "instructive" rather than grounded in objective empirical evidence (5, 379; cf. 5, 382). And while, late in the third *Critique*, Kant reintroduces the notion of a final end of nature, he denies that this end could be "in nature (as a sensible being)," i.e., could be part of the possible subject

matter of empirical science, or of theoretical cognition as such (5, 435; cf. 5, 442ff.; 5, 449). For further discussion of these issues, see Pereboom (1996), Goy (2013), Watkins (2014), Winegar (2015), and Fisher (2018).

³² See also, for the human case, 5, 368: "only *if* one assumes that human beings have to live on the earth would there also have to be at least no lack of the means without which they could not subsist as animals..."; Kant does not regard the antecedent assumption as justified, however. Kant also stresses the contingency of human populations in particular regions, such as Tierra del Fuego (5, 378).

account of, for example, arctic snow. This account would make no reference to the benefits of snow to plants. The contingency of the relationship between arctic snow in plants appears to be grounded, in turn, on a lack of the reciprocal dependence relations Kant believes are required for concluding that merely mechanistic explanation is insufficient. That is, while arctic plants may partly depend on snow, the snow does not in turn depend on the plants, and can presumably be explained mechanistically.³³

Kant reiterates this claim with another example. He notes that the sandy soils of his native East Prussia are inhospitable to many plant species, but allow pine trees to thrive. Some individual pines in a community would not even exist if the soil type were different. Nevertheless, the existence of the sandy soil can be explained mechanistically, if we assume that this region was covered by an ocean in the geological past.³⁴ The soil in a dry and treeless sandy region could have just the same geological explanation. As Kant concludes, the empirical evidence does not entail that “the sand in itself, as an effect of its cause, the sea, could not be comprehended without ascribing a purpose to the latter” (5, 368). To consider a simple analogy, a brick is a potentially useful tool for breaking windows when thrown at them. This can be explained,

³³ Cf. Kant’s remark that no “relation to ends” can be “present[ed]” for “wind, rain, etc.” (5, 383). In scientific writings, Kant sketched broadly mechanistic explanations of some meteorological phenomena, for example in the 1756 “New Notes to Explain the Theory of the Winds” (1, 489–503) and the 1794 “Influence of the Moon on the Weather” (8, 315–324). In early works, however, he sees meteorological phenomena as bringing about effects “for the purposes of...human beings and animals” (1, 225).

³⁴ See 5, 367. This example is essentially the same, *mutatis mutandis*, as Linnaeus’s case of desert soils and succulents, as discussed above.

however, simply in terms of the properties of bricks, such as their shape and density: bricks do not exist in order to be thrown at windows.³⁵ Final-causal explanation is not indispensable in any of these cases.

Kant also registers some more general worries about relations of benefit, which could equally apply to more anthropocentric teleological systems, such as Wolff’s. He asserts, first, that if the non-living environment or “habitat” (*Wohnplatz*) existed for the benefit of living beings, it would precisely match their needs (5, 427). But in fact, disasters and fossil evidence for mass extinctions³⁶ suggest that the environment does not match the needs of living beings. Such “ancient, powerful devastations” that potentially affect “every creature” seem to result from mere “forces of nature” rather than any well-ordered purposive system (5, 427–8). Second, Kant suggests that even what seem to be clear cases of benefit may look more neutral from a broader perspective, since benefit to one species or population may come at the expense of others.³⁷

3.2 *Beneficial Relations Between Species*

Kant also considers a case that appears more challenging for his position: that of interspecies relations between predator

³⁵ See Kant’s discussion of the various ways a stone can be used (20, 240). Kant also mentions the example of the oceans as a “great storehouse of water” for evaporation and condensation, which ultimately benefits life on land, but which cannot be taken to exist for that purpose (5, 270).

³⁶ As Kant was writing the third *Critique* in the late 1780s, the fossil evidence for such extinctions was still inconclusive; it was only in 1796 that Cuvier firmly established it.

³⁷ The erosion and redepositing of soil by a river, for example, may well take away as much fertile soil from some populations that “just as much...as is added” for the benefit of others (5, 365–6).

and prey, such as the specific case of herbivores preying on plant populations. Here he refers to Linnaeus by name:

One could also, with the Chevalier Linné...say that the plant-eating animals exist in order to moderate the excessive growth of the plant kingdom, by which many of its species would be choked; the carnivores exist in order to set bounds to the voraciousness of the plant-eaters; finally, humankind exists in order to establish a certain balance among the productive and destructive powers of nature by hunting and reducing the number of the latter. (4, 427)³⁸

Kant regards Linnaeus's global claim as merely hypothetical. It will be helpful to distinguish two aspects of this hypothesis. The first is its commitment to *holistic* explanation. The Linnaean hypothesis, on Kant's reading, purports to explain the features of individual organisms in terms of larger groups or wholes they are part of. The second is the explicit appeal, in the Linnaean hypothesis, to *final-causal* explanation: the idea that, for example, carnivores exist for the sake of moderating the effects of herbivores. I suggested in section 2 above that Linnaeus does, in fact, endorse both of these explanatory claims.

Kant contends that the question of why a species exists is ill-posed: no empirical evidence could show that (for example) carnivores exist for the sake of herbivores rather than vice versa. Note, however, that the holistic explanatory claims of Linnaeus's hypothesis could be justified, even if its claims about final-causal explanation are not. On the Linnaean

hypothesis, some properties of individual organisms depend on properties of groups, such as population size: the predator-prey relation has overall advantages for both predator and prey organisms. So it appears that given Kant's criterion for merely mechanistic explanation, these properties of organisms would not be mechanistically explicable if Linnaeus's hypothesis is assumed. Outcomes for a member of a species would instead be explained in terms of mutual interaction between the individual and the species (rather than the way that wholes are asymmetrical "product[s]" of their parts in merely mechanistic explanation (5, 408)). Even properties of whole species could hypothetically be explained in terms of a more general "system of all the kingdoms of nature in accordance with final causes," such as Linnaeus's economy of nature (5, 427).

Kant does not explicitly argue against the holistic features of Linnaeus's hypothesis. He does not, for example, insist that species consist of individual organisms and therefore depend on them. Nor, to my knowledge, does Kant consider the third kind of Linnaean case discussed above, in which one species benefits others in the transition between two plant communities. Kant does explicitly not rule out a role, in such cases, for non-mechanistic explanation of a species' "relation to the whole," or of reciprocal dependence between species and the "form" of a plant community (5, 373). Here, one possible Kantian position would be to grant that such Linnaean hypotheses may be useful, while denying that we are justified in considering them to be *indispensable* in anything more than a provisional sense.³⁹ But his texts also seem consistent with

³⁸ Compare Linnaeus (1972, 107-8 [PN I.8]): "it is a widely held opinion that plants were created for animals; but...I adopt an entirely contrary view, for I easily perceive that *animals* were created *for plants*." Also compare Kant's reported remark (in a lecture from the mid-1780s) that prey animals

may become paralyzed by fear because it is their "destiny" to be "prey for the predators" (25, 1342).

³⁹ They may be "permissible hypothes[es]" (5, 415). See also footnote 45 below.

granting an indispensable role for holistic (thus non-mechanistic) explanation in these cases, but not for full-blown final causality.

What does Kant actually write about beneficial relations among species? It is striking that he takes them to be relations of contingent use, just as in the cases of benefit from the non-living environment that were considered in the previous section. As he writes:

...The objective purposiveness which is grounded on advantageousness is not an objective purposiveness of the things in themselves, as if the sand in itself, as an effect of its cause, the sea, could not be comprehended without ascribing a purpose to the latter and without considering the effect, namely the sand, as a work of art. It is a merely relative purposiveness, *contingent in the thing itself to which it is ascribed*; and although in the examples we have given the species of grasses themselves are to be judged as organized products of nature, hence as rich in art, nevertheless in relation to the animals which they nourish they are to be regarded as mere raw materials. (5, 368; emphasis added)

To expand on Kant's claim at the end of this passage, it is conceivable that organisms of various kinds could serve the same beneficial role for grazing animals. A pair of oxen, for instance, might be relocated so as to graze on entirely different species. Or they might be transferred to a farm and feed mostly on grain. While the oxen clearly require food that meets some

dietary constraints, there need not be any specific food source that *uniquely* satisfies these constraints.⁴⁰ That is, the oxen's relationship to their food is one of mere "contingent use" (20, 249). I take this to be the point behind Kant's suggestion that any given species of grass is "mere raw material" for a grazing mammal such as an ox.⁴¹ This tells against Linnaeus's claim that each species has a particular or even unique function in the economy of nature. By contrast, an ox's organs and other functional parts not mere raw materials, since the ox's well-being partly depends on them in particular or even *uniquely*.

3.3 Revisiting the Indispensability of Final Causes

Above, I argued that Linnaeus accepts a *parity of explanation* principle: not only individual organisms but also species, communities, and indeed the whole 'economy of nature' must be explained in both holistic and final-causal terms. We've now seen that while Kant clearly denies the latter claim (concerning final-causal explanation), the status of holism is unclear. In this section, I specify more precisely what feature that makes final-causal explanation indispensable is lacking in cases such as inter-species benefit.

We saw above that Kant thinks that a given relation of benefit between species could have been otherwise: the ox could be benefited just as much by other plant species. By contrast, the role played by an organism's functional part could not be so easily replaced by some similar alternative. An especially

⁴⁰ Analogously, there are typically constraints on the material out of which an artifact is made: the head of an axe must be hard in order to split wood, to use Aristotle's example (*Parts of Animals* 642a10). As Aristotle adds, within these constraints an axe head could then be made of various kinds of material. This analogy could explain Kant's reference to "material" in

these contexts, though Kant also points out key differences between organisms and artifacts (5, 374–75; cf. 20, 215).

⁴¹ This may not be the best choice of example. Linnaeus argues on an empirical basis that herbivore diets vary greatly by species, and are not especially flexible (Linnaeus (1762), 76 [ON §9]; 98–100 [§15]). But Kant's point can be generalized.

strong version of this claim appears in a work from 1763, once again using the example of a plant:

Consider the vessels which draw up sap, vessels which take in air, those which process the sap and those which exhale it, and so on. *These various vessels make up a great manifold, where none is capable of producing the effects of the others*, and where their combination into unified and perfect whole is artificially devised, so that the plant itself, which is related to such a diversity of purposes, constitutes a unity which is contingent in character and the product of choice. (2, 107; emphasis added)

Kant's point here is not just that a particular type of functional part in the plant is dependent on the others, or even on the plant as a whole. Nor does he mean simply that each part of an organism can in some sense or other be judged teleologically, a claim endorsed in the third *Critique*.⁴² What he is claiming is that each type of part plays a precise, indeed *unique* role in the plant's well-being. No type could play the role of any other. This species or of plant must contain *this very* type of functional part to play a specific role, and such precise relations may also obtain between types of functional part.⁴³ An organism does not contingently use its functional parts as if they were "mere raw material[s]," because an organism of that kind could not have had other parts playing that function.⁴⁴

⁴² "Anatomists of plants and animals, in order to investigate their structure and to understand for what reason and for what end they have been given *such* a disposition and combination of parts and *precisely this* internal form, assume as indispensably necessary the maxim that nothing in such a creature is *in vain*..." (5, 376; emphases added).

⁴³ See 5, 371: "one part of this creature...generates itself in such a way that the preservation of the one is reciprocally dependent on the preservation of the other."

Using contemporary terminology, we might say that on this view there is a one-to-one dependence relationship between a species and each of its types of functional part.

It does not follow that a given species could not have been otherwise. Consider the familiar case of the human heart and its functions for a human being. Intuitively, the heart as it actually exists is not the only possible structure that could fulfill these functions. If the heart were structured differently enough, however, other features of the circulatory system would have to change as well. This is, once again, stronger than the mere claim than that the heart must be explained through its "relation to the whole."

I take this sort of unique dependence relationship to be part of what Kant has in mind by claiming that the functional parts of a tree contribute to the persistence of its *form*. That is, the parts do not only preserve its existence — this would be true of many raw materials, such as soil, the plant needs to survive — but preserve it *qua* member of this very species of plant.

So far, Kant's position affords a clear distinction between organisms and larger groups, and is also capable of making his appeals to form more empirically serviceable. One could object, however, that his claims are empirically false. We now know that artificial hearts are possible, for example, and that cross-species organ transplants are sometimes successful.

⁴⁴ Conversely, a single kind of raw material can be involved in the production, via "separation and new composition," of many kinds of organisms or functional parts (5, 371; cf. 5, 377). Kant elsewhere invites readers to consider "what an immeasurable manifoldness of partly volatile matters the realm of plants produces from...ordinary water, presumably through decomposition and other kinds of connection" (12, 34).

Interestingly, Kant himself notes that the relationship between species and their functional parts is not always so tight-knit:

An eye from the leaf of one tree grafted into the twig of another brings forth a growth of its own kind in an alien stock, and similarly a scion attached to another trunk. Hence 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....[Moreover,] in the case of injury...the lack of a part that is necessary for the preservation of the neighboring parts can be made good by the others... (5, 371–372)

In the case of grafting, an individual of one species can acquire functional parts of another species. In the case of self-repair, a given functional part can take on the role of another. These examples show that one type of functional part may in fact be capable of producing the effects normally brought about by other types. And, conversely, Kant suggests that unique type dependence relations can obtain outside of individual organisms in the case of sexual reproduction: “it seems that it must be impossible for organic creatures to come into being from the matter of our world through reproduction in any other way than through the two sexes established for this purpose” (7, 178 (n.)).

So Kant seems to have been attentive to empirical counterexamples to his position. But these examples blur what was a previously clear distinction between organisms and what

Kant calls external purposes. A plausible way of reading Kant’s position — though never, to my knowledge, spelled out in his texts — is that the explanatory demands posed by organisms and by external purposes differ in *degree*, rather than in kind. This is compatible with a difference in kind between individual final-causal and mechanistic explanations. On Kant’s view the overall account of a natural end involves the “association” of various individual mechanistic and teleological explanations, but precisely how much of each kind of explanation is needed could vary by degree, depending on variations in the relevant empirical evidence (5, 421).⁴⁵

4. *Conclusions: Contemporary Debates on Holism and Final Causes*

Kant’s engagement with Linnaean ideas is of independent historical interest. But Kant’s discussion can also be considered from a broader perspective, in order to draw connections with more recent debates in contemporary ecology, biology, and philosophy. In this section, I sketch a few of these connections. To help do so, I make use of analytical categories and vocabulary from the contemporary literature. I do not, however, claim that Kant and Linnaeus — the historical actors — themselves employed or anticipated these categories.⁴⁶

i. *Final causation and indispensability.* Goal-directed or teleological language is not unusual in contemporary ecology and conservation biology, but critics have suggested that such attributions rely uncritically on a fixed, teleological order of

⁴⁵ One way to ground this proposal in Kant’s texts would be in terms of hypothetical or technical imperatives (cf. 5, 25 (n.)). There are certain conditions under which empirical evidence generates a practical demand for final-causal explanation. In some cases, however, this demand could be weak, merely permitting useful final-causal hypotheses insofar as it is

unknown whether the antecedent condition of the hypothetical imperative is fulfilled (cf. 5, 415 and section 3.2 above).

⁴⁶ Historians debate the extent to which Linnaeus and other eighteenth-century natural historians influenced the formation of ecology in the late nineteenth and early twentieth centuries; see e.g. Worster (1977), McIntosh (1985), Drouin (1991), and Pearce (2010).

nature. Yet if living collectivities are merely arbitrary human projections, difficulties seem to arise for conservation policy and environmental ethics, which often take such collectivities as given.⁴⁷ One philosophical response has been to read seemingly teleological attributions as heuristic or ‘*as-if*’ metaphors which do not require any commitment to a top-down order of nature. Yet such an approach raises further philosophical questions. Are the heuristics in question merely optional? Do they play an indispensable explanatory role? And even if they are indispensable, are they actually justified — rather than simply being the best of the bad lot?

Kant’s critical engagement with Linnaeus, I hope to have shown, goes well beyond asserting the indispensability of final-causal explanation, and towards articulating when it is and is not justified. If one holds, as not only Kant but many contemporary philosophers do, that final-causal explanation is sometimes indispensable in the life sciences, one’s position can be greatly strengthened by articulating why its use is justified in some cases but not others. Note that Kant does not use a pre-existing definition of biological individuality, for example in terms of substance, to determine the scope of final-causal explanation; I take this flexibility to be an advantage of his account.

⁴⁷ See e.g. McShane (2004); Jax (2010); Steen, Barrett, Clarke, et al. (2017).

⁴⁸ McIntosh (1985, 13) defines an “organic” style of natural history as assuming that “the whole exists first and its design explains the action of the parts”; holism and teleological “design” are conflated here. Another example is the recent exchange between Donhauser (2017) and Sagoff (2017): while both authors raise important questions about the status of final causality in ecology, they also tend to conflate any top-down approach to explanation with teleology or final causality.

ii. *Holism and final causation.* Holistic and final-causal explanation are frequently conflated.⁴⁸ Kant, however, takes final-causal explanation to involve additional conditions, beyond what is sufficient to motivate holistic explanation.

Here one can draw useful connections to the contemporary distinction between *organizational closure* and *organizational differentiation*. The former corresponds roughly to holism. A system exhibits organizational closure when its components contribute to the existence of its maintenance and properties, but also partly depend on relational or global properties of the system. A common claim in the recent literature is that organizational closure is a necessary but not sufficient condition for analyzing biological functions.⁴⁹ This is in part because components in an organizationally closed system may perform a mere ‘use’ or ‘service’ function for the system that could easily be played by something else.⁵⁰ For example, contemporary ecological discussions of the predator-prey relations considered by Linnaeus and Kant often regard *families* rather than species of organisms as the key functional groups, such that many species could play a given predator or prey role in an ecosystem.⁵¹ And more recent discussions typically reject the idea of a Linnaean ‘station’ as uniquely fitted to a particular species. Instead, similar species can evolve independently in numerically different but functionally similar

⁴⁹ See Mossio, Saborido, & Moreno (2009); Nunes-Neto, Moreno, & El-Hani (2014); and for a related earlier approach Wright (1976, 39). On related debates in the late nineteenth and early twentieth centuries, see Gibson, Kwapich & Lang (2013) and Baedke (2019).

⁵⁰ Cf. Achinstein (1977), McLaughlin (2001, 46–47), and Dussault (2018). The phrase ‘use function’ calls to mind Kant’s definition of relative purposiveness in terms of *contingent use*.

⁵¹ See Jax (2010); Huneman (2011); and Nunes-Neto, Moreno, & El-Hani (2014).

environments, and one species can occupy a ‘station’ previously occupied by another.

An additional proposed necessary condition for biological functions proper would be that the system is *organizationally differentiated*. This means that the system depends on the specific or differentiated role of given types of part whole system depends on the specific or differentiated role of a given type of part. Compare the causal role of the heart in a human body, discussed above, with that of a certain collection of gas molecules in a whole system of such molecules. The causal role of this collection of molecules is very similar to that of some other collection. Parts of machines are also typically differentiated in this way, suggesting that organizational differentiation may be an important condition for the indispensability of final-causal explanation. More broadly, both Kant and contemporary organizational approaches suggest that structural features of an organism (such as interdependencies between parts) can be identified before the functions of the organism’s parts have been discovered; such structural features can guide subsequent inquiry. Kant’s discussion of a leaf (5, 372), for instance, does not assume the leaf’s function is known in any detail.

Recent scholarship on the organizational approach notes Kant as an inspiration or historical antecedent.⁵² But his arguments are rarely considered in detail, as I’ve tried to do here.

iii. *Final-causal explanation and differences of degree*. In section 3.3, we saw that Kant allows that there is some flexibility in the functional structure of organisms, as shown by cases like grafting and self-repair. While this suggests that the

need for a certain mode of causal explanation might come in degrees, Kant does not explicitly embrace this idea.

Such a proposal has been defended, however, in recent philosophy of science, suggesting possible extensions of a broadly Kantian account of the indispensability of explanation. This point is often put in terms of *degrees of causal specificity* — notably by Woodward (2010). As with other scalar or degree properties, one can begin by identifying differing cases where there is a large degree of difference. Consider, for instance, the difference between a infant cow’s causal dependence on its mother and its dependence on the mother’s milk as nourishment. Woodward suggests that a reciprocal causal dependence relation is increasingly causally specific to the extent that it approximates a one-to-one dependence relation between types (Woodward (2010, 308ff.)). This is compatible with there being few, if any, actual cases of such one-to-one type dependence studied by the life sciences. We can also allow that our actual judgments about causal specificity are relative to contingent empirical evidence.

Section 3.3 laid out textual evidence that Kant may have also considered unique or one-to-one dependence relationships (between organisms and their functional parts) as paradigm cases of indispensable final-causal explanation. But we saw that his views evolved on this point, perhaps in response to empirical evidence. In 1763, Kant appears to have endorsed something like a one-to-one dependence relation between species and each of their types of functional part. In the third *Critique*, composed in the late 1780s, Kant expresses a more nuanced position, in terms of examples such as grafting and self-repair. Nothing in Kant’s account seems to rule out further empirical evidence for causal specificity beyond the boundaries of organisms as

⁵² E.g. Nunes-Neto, Moreno, & El-Hani (2014, 128), Baedke (2019, 307).

traditionally understood.⁵³ Instead, on a Kantian account, we can better understand how such cases differ from paradigm single-organism examples. In sum, although Kant's insistence on the special explanatory status of organisms may be debatable, I hope to have shown that his justification for this position is not dogmatic, and is sensitive to developing empirical evidence.

Acknowledgments

Many thanks to Antoine Dussault, Katharina Kraus, Daniel Lindquist, Sam Newlands, Phillip Sloan, Jessica Williams, and several anonymous referees for helpful comments and discussion. I am also grateful to participants at the 2018 meeting of the Philosophy of Science Association, where an earlier version of this paper was presented.

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⁵³ Historically, a frequently discussed case has been functional specialization and interdependence in social insect colonies or swarms: individual insects or structures like honeycomb have been seen as analogous to organs. Some

relevant features of bee colonies were already mentioned in Classical works (e.g. Aristotle, *Generation of Animals* 760a4; cf. *History of Animals* 553a–554b and 623b–628a). Kant does not examine this topic in detail, however.

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