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Are Organisms Substances or Processes?

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ABSTRACT

I argue that attempts in the philosophy of biology to show that organisms are processes, rather than substances, fail. Despite what process ontologists have said, substance ontology is perfectly able to accommodate the dynamic nature of organisms, their ecological dependence, and their vague boundaries, and their criticisms are directed not at substance ontology *simpliciter*, but only at specific (perhaps untenable) characterisations of substances. The paper ends by considering what a processual philosophy of biology that is radically in conflict with an ontology of substances might look like.

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1. Introduction

Some philosophers of biology claim that living entities, such as organisms, are processes rather than substances. As John Dupré and Daniel Nicholson [2018: 3] write:

[t]he world—at least insofar as living beings are concerned—is made up not of substantial particles or things, as philosophers have overwhelmingly supposed, but of processes.

This processual view of living entities is increasing in popularity (see Baptiste and Dupré [2013], Guay and Pradeu [2016], DiFrisco [2018], Meincke [2019], and Nicholson [2019]). Its proponents, the so-called ‘process ontologists’, argue that philosophical and empirical considerations require us to take living entities to be processes rather than substances, and that doing so constitutes a radical ontological shift in Western philosophy [Dupré and Nicholson 2018: 11]. If process ontologists are right, this would therefore be important news for metaphysics and the philosophy of biology.

The aim of this paper is to consider whether process ontologists provide good reasons for abandoning an ontology of living substances. I argue that they do not. Specifically, the main claims that process ontologists make about living entities are not only compatible with the usual historical and contemporary accounts of substance, but are also often accepted by substance ontologists. There is no need, therefore, to abandon the well-established tradition that takes organisms to be substances.

The structure of the paper is as follows. I begin by outlining the usual accounts of substance. I then present the main claims that process ontologists have made about the nature of living entities,¹ arguing that these are compatible with living entities being

substances, on these usual accounts of substance, and that they are often accepted by paradigmatic substance ontologists. I conclude that process ontologists are objecting only to specific characterisations of substances—ones that take substances to be three dimensional, generically ontologically independent, persisting in virtue of an unchanging essence, and to have precise boundaries—characterisations that do not figure in the usual historical and contemporary accounts of substance, and that are often rejected by substance ontologists. Finally, I consider what a processual philosophy of biology that would cause trouble for an ontology of substances, and that would have radical implications for debates in the philosophy of biology, might look like.

Following Dupré and Nicholson [2018], I use ‘substance’ and ‘thing’ interchangeably,² using ‘entity’ as a neutral term to refer to both substances and processes. Furthermore, when I talk about ‘process ontology’, I am talking about process ontology *in the philosophy of biology*, and not in other domains such as the philosophy of physics or ontology, more generally.³

2. Accounts of Substance

What is substance ontology? This is difficult to say. The introduction of the term ‘substance’ is often credited to Aristotle, and has been prominent in the works of Locke, Hume, Kant, and many others. Whilst it has generally been agreed that substances are in some sense basic or fundamental entities, and that living entities are paradigmatic substances, there is no universal agreement about how substances should be characterised. In this section, I briefly present the most influential accounts of substance in the history of philosophy, many of which are discussed in more detail by Hoffman and Rosenkrantz [1997]. There are controversies about how these accounts should be understood, and whether they are rivals. My aim, however, is simply to provide a feeling for how substances are often understood.

The Negative Account: *a substance is that which is neither said of, nor in, a subject.*

In *Categories* [2a11], Aristotle says that a substance is that which is neither *said of*, nor *in*, a subject. The idea is that a substance is neither a state, an activity, or a property (or an aspect or condition) of anything else, unlike a wrinkle in the carpet which is simply a modification of the carpet [van Inwagen 2015: 27]. Socrates’ tiredness is not a substance because it is a state of him. On the other hand, Socrates is not a state, activity, or property of anything.

The Independence Account: *a substance is something that depends on no other entities for its existence.*

A popular account of substance takes substances to be ontologically independent entities. Descartes [1985: 210] writes:

¹ I mostly focus on the work of Dupré and Nicholson, and others, in *Everything Flows: Towards a Processual Philosophy of Biology* [2018].

² ‘Thing’ is often used by philosophers in a more neutral way, interchangeably with ‘object’. Used in this way, any entity, including a process, is a thing.

³ For work on the latter, see Seibt [1997].

By substance, we can understand nothing other than a thing which exists in such a way as to depend on no other thing for its existence.

How independence is to be understood is up for debate (see Toner [2011], Gorman [2006], and Lowe [1998]), and is something to which I will return in section 4.⁴ The relevant sort of independence, however, is normally taken not to be *causal* independence, but rather some sort of *ontological* or *metaphysical* independence [Lowe 1998: 136–7]. One difference between causal and ontological independence is that causal independence is thought to be diachronic, whilst ontological independence is thought to be synchronic.

The Persistence Account: *a substance is any entity that can persist through change.*

Aristotle [Categories: 4a10] also claimed that a substance is that which can remain numerically one and the same whilst receiving contrary properties.⁵ A human being, for example, is a substance because it remains the same entity, despite being bent over at one time and standing straight at another.

The Substratum Account: *a substance is a propertyless bare particular.*

It has been suggested that substances are *bare particulars*—entities in which properties *inhere*, whilst lacking properties in their own right [Descartes 1985: 156; Hoffman and Rosenkrantz 1997: 17]. According to this account, a substance is what would remain if a human being was stripped of its properties.

The Form and Matter Account: *a substance is a form-matter complex.*

In *Metaphysics Z* [Metaphysics: 1029a5–30], Aristotle says that substances are *form-matter* complexes. The matter of an object is what it is made of, whilst the form is what makes it the sort of object that it is. A table, for example, according to this account, is a composite of both some matter (such as particles or some wood) and a *table-form*.

This completes my brief look at the usual historical and contemporary accounts of substance.⁶ Again, my intention was just to give an idea of how substances have been understood, rather than to analyse each account in detail. Importantly, we have seen that there is no such thing as *the* substance view. Objections to an ontology of substance, therefore, will need to make it clear which account(s) of substance they are objections to, or identify a problematic feature of all or most accounts of substance. Process ontologists are not explicit about which account(s) of substance they are addressing, but I will argue that *all* of the usual accounts of substance discussed in this section are immune to their objections.

3. Processes Are Extended in Time

Process ontologists often claim that living entities, and other processes, are extended in time by having temporal parts [DiFrisco 2018; Dupré and Nicholson 2018].⁷ What is a

⁴ The Negative Account is arguably a version of the Independence Account [Hoffman and Rosenkrantz 1997: 21].

⁵ For elaboration, see Hoffman and Rosenkrantz [1997: 9].

⁶ Two historical accounts of substance that I have not discussed are those presented by Spinoza [1996: 1p14] and Leibniz [1991: §§8: 14]. Their omission, however, does not affect my argument.

⁷ It is generally agreed that all processes are extended in time, although not everyone agrees. Stout [1997], Galton and Mizoguchi [2009], and Meincke [2018] are some dissenters.

temporal part? The idea is that, just as entities are spread out across different spatial regions by having different spatial parts located at those regions, processes (and other temporally extended entities) are spread out across time by having different temporal parts located at different times. Consider a process such as fermentation, which has three stages. Suppose that the first stage occurs on 1st March, the second stage between 2nd March and 4th March, and the third stage between 4th March and 14th March. Assuming that processes have temporal parts, each stage corresponds to a distinct temporal part occurring at different times—one located at 1st March, another located between 2nd March and 4th March, and another located between 4th March and 14th March. Notice, then, that entities with temporal parts are never *entirely* present at a time, but are only partly there by having a part located at that time [Olson 2007: 100]. Our instance of fermentation, for example, is only partly present at 4th March by having a temporal part located there.

According to processual philosophers of biology, living entities are like fermentation. Human beings, for example, have not only spatial parts such as cells and organs, but also temporal parts such as *the first half of one's life*—entities that look just like human beings but exist half as long as do the humans of which they are part. They also have *foetal temporal parts*—entities that span around the first 40 weeks of a human being's life. I was, therefore, never wholly inside my mother's womb, but was only partly there in virtue of having a temporal part that was inside her womb.

Do substance ontologists take living entities to have temporal parts? Some philosophers who we might identify as substance ontologists think that material entities only have spatial parts (see, for example, Wiggins [1980], van Inwagen [1990], and Lowe [1998]). These philosophers, often called 'three dimensionalists' (in contrast to proponents of temporal parts, who are often called 'four dimensionalists'), take material entities to be wholly present at each time that they exist. Unlike proponents of temporal parts, they would believe that I existed yesterday not in virtue of having a temporal part that was present yesterday, but because 'all of me' was present yesterday. James DiFrisco [2018: 79], however, claims that taking entities to have temporal parts requires 'discarding the category of substance as the paradigm for individuality in favour of the weaker and more flexible category of process'. If he is right, then living entities cannot be both substances and temporally extended.

Suppose that living entities do have temporal parts. I'm not convinced that this would require discarding the category of substance. It seems to me that whether entities have temporal parts is an issue orthogonal to those about substances. This is because the usual accounts of substance presented in section 2 are compatible with substances having temporal parts. Consider The Negative Account: something, such as an organism, could have temporal parts whilst also being neither a state, an activity, or a property of anything else. Similarly, something could have temporal parts whilst also being ontologically independent, and so qualify as a substance, according to the Independence Account. The same is true of the Form-Matter Complex and Substratum accounts.

What about Aristotle's Persistence Account (which, recall, takes a substance to be something that can remain numerically one and the same, despite receiving contrary properties)? 'Persistence' is usually understood neutrally to capture both three dimensional and temporal parts (or four dimensional) views of change [Lewis 1986; Sider 1997]. Consider a hot poker that becomes cold. According to three dimensionalism,

the poker is first hot, and then cold, in virtue of having the property of being hot at an earlier time and having the property of being cold at a later time. In contrast, according to temporal parts views, the poker is hot and then cold, not by literally having the properties of being hot and then cold, but in virtue of having a temporal part located at an earlier time that has the property of being hot, and having another temporal part located at a later time that has the property of being cold.

Despite this, it might be argued that temporal parts views are incompatible with something remaining *numerically one and the same, despite receiving contrary properties*, as Aristotle's Persistent Account requires [Seibt 1997: 149]. Consider our poker example. As we have seen, unlike three dimensionalism, which takes the poker to be literally hot and then literally cold, temporal parts views take the poker to be hot and then cold, only in the non-literal sense of having a hot temporal part and a cold temporal part. Strictly speaking, then, it is not numerically one and the same entity that is first hot and then cold; there are distinct temporal parts.

With that being said, it is nonetheless numerically one and the same poker that has the hot and cold temporal parts as parts, and we do often attribute a property to something only if one of its parts has the property: we say, for example, that I am sunburnt even though only my ears are sunburnt [Olson 2007: 123].

We can distinguish, therefore, between two interpretations of Aristotle's Persistence Account: First, there is a 'strict' interpretation, which holds that something persists through change only if it literally has contrary properties at different times. This is incompatible with an ontology of temporal parts. Second, there is a more 'generous' interpretation, which allows that temporally extended entities can be numerically one and the same whilst receiving contrary properties, in the sense of having temporal parts located at different times with contrary properties. The generous interpretation is compatible with substances having temporal parts. Unfortunately, Aristotle never mentioned temporal parts, and so we can't be sure whether he would be happy to accept the generous interpretation. At any rate, it seems to me that there is a legitimate interpretation of Aristotle's Persistence Account that has not yet been ruled out, and that is compatible with an ontology of temporal parts.

All of the usual accounts of substance, therefore, are compatible with an ontology of temporal parts. If it turns out that living entities have temporal parts, this is not a reason to abandon an ontology of substances.

4. Activity, Stasis, and Persistence

Process ontologists often say that processes are dynamic whilst substances are static [Dupré and Nicholson 2018: 13–14; Meincke 2018: 369; Nicholson 2018: 154]. As Dupré and Nicholson [2018: 14] write, 'the default mode of a thing is stasis ... For a process, however, change is the norm.'

No one would deny that living entities are constantly changing. They have a metabolism, meaning that they are constantly taking in matter from their environment in order to sustain themselves, and expelling matter that they no longer require. Even as I write this, my cells are constantly being replaced. Furthermore, living entities *require* a metabolism. As Dupré and Nicholson [ibid.: 15] point out, leave a stone in your loft and it will be there ten years later, but leave your pet hamster there for a few weeks and there certainly won't be a hamster to come back to! Dupré and

Nicholson [ibid.] find metabolic turnover to be ‘[o]ne of the strongest motivations for adopting process ontology in biology’. As they say [ibid.: 17],

[o]verall, the reality of metabolism forces us to recognize that organisms, despite their apparent fixity and solidity, are not material things but fluid processes ... As process, and unlike things or substances, organisms have to undergo constant change to continue to be the entities they are.

If it is right to characterise substance as static and unchanging, then Dupré and Nicholson would be absolutely right that the active nature of living entities forces us to deny that living entities are substances. Such a characterisation, however, is not right. First, none of the usual accounts of substance presented in section 2 imply that substances must be static. All of them are entirely compatible with substances being dynamic and having a metabolism. Second, substance ontologists often stress that paradigmatic substances are dynamic and constantly changing. As Helen Steward [2020: 48] points out, Aristotle—the paradigmatic substance ontologist—takes living entities to be paradigmatic substances, and invokes the form-matter distinction precisely in order to accommodate persistence through change. According to Montgomery Furth’s [1978: 638–9] interpretation, Aristotle takes a living substance to be

a semi-permanent warp or bend informing the local matter, which the matter flows through at various rates during the organism’s life history (this is called metabolism), while the form imposes the continuity.

For Aristotle, then, paradigmatic substances are dynamic. Dupré and Nicholson [2018: 6] do say that Aristotle’s understanding of living substances is ‘more congenial to a process perspective than that of his followers’. This is odd, though, because many of his followers follow him in stressing the dynamic nature of living substances. David Wiggins [1980: 84–90], stresses the remarkable ability of living substances to renew themselves through change. He argues that substances have a *principle of activity*—something that determines what an entity is, and that establishes its spatial and temporal boundaries [Wiggins 2001, 2012, 2016: 213]. It isn’t entirely clear what Wiggins takes the principle of activity for living substances to be, but he is happy for this to be fleshed out with biological detail. Adam Ferner [2016: 141], for example, suggests that it might be understood in terms of immunological activity. Furthermore, Peter van Inwagen, who says [1990: 15] that his account of living things is ‘extraordinarily like’ Aristotle’s account of living substances, holds that each living entity has a *life*—a self-maintaining biological activity that constantly takes in matter from the organism’s environment, unifying that matter into its structure and expelling any matter that it no longer requires [ibid.: 87]. Aristotle’s followers, then, are explicit that living things are dynamic rather than static.

Perhaps it will be argued that, in biology, substance ontology is often tied to the machine conception of the organism (MCO), which takes living entities to be little different from complex artefacts such as clocks or engines (see Nicholson [2013, 2018]). Nicholson [2018] argues that, given the metabolic nature of organisms, which sets organisms apart from machines, MCO is inappropriate. As Steward [2020: 47–8] points out, however, whilst MCO might be tied to substance ontology *in biology*, substance ontology was introduced by Aristotle long before MCO, and Aristotle’s account of living substances as dynamic self-renewing entities clearly denies that organisms are machines.

It might be argued that, when process ontologists say that substances are static, they don't mean that substances cannot change their matter, but that they have an *unchanging essence*, or *core*, that persists through change [Guay and Pradeu 2016: 318; Dupré and Nicholson 2018: 24; Meincke 2019: 5]. As Dupré and Nicholson [2018: 24] write,

things persist ... by virtue of their continued possession of certain essential properties, which make those things what they are and which remain unchanged over time.

Similarly, Miencke [2019: 5] says that

there is believed to be an intrinsic unchanging core in every substance, defined by a set of essential properties or capacities.

Their claim is that substances are supposed to possess some special permanent properties that are necessary for them to exist. This has been referred to as 'Essentialism'. Dupré and Nicholson [2018: 24] take Essentialism to be problematic:

The problem for substance ontology has always been that it is extraordinarily difficult to specify any such change-exempt descriptive properties that permanently characterize the essence of things.

Substance ontologists, however, need not, and often do not, take organisms to have an unchanging essence or core. Notice that none of the accounts of substance outlined in section 2 refers to an unchanging essence or core. Importantly, many substance ontologists do not appeal to this idea either. Steward [2020: 50–1] takes living substances to persist through change in virtue of the spatiotemporal continuity of their matter.⁸ She makes no mention of an unchanging core or essence. Wiggins [2016: 272] also notes that his principle of activity does not require substances to have a 'permanent core'. It is true that he takes an organism's principle of activity to be essential to it, but this view is relatively harmless if an organism's Principle of Activity is articulated in terms of biological processes and interactions, as was suggested by Ferner.

More interesting for our purposes is the account of persistence defended by van Inwagen and Olson [van Inwagen 1990: 143–5; Olson 1997: 135]. Following Locke, van Inwagen takes an organism to persist just so long as its biological life continues—a life, as we saw, being a biological activity encompassing all of an organism's lower-level living activity. Olson [1997: 135] presents this idea in terms of vital functions:

If *x* is an organism at *t* and *y* exists at *t**, *x* = *y* if and only if the vital functions that *y* has at *t** are causally continuous with those that *x* has at *t*.

How 'vital functions' or 'life' should be understood is up for debate, but Olson and van Inwagen are happy for this to be filled in with biological detail [van Inwagen 1990: 84; Olson 1997: 136]. We might, for example, understand those ideas in terms of metabolic, or immunological, activity or some other biological process. The idea, though, is that I am identical to someone in the future or the past in virtue of being causally connected to that future or past being by the relevant biological functions or activities that keep us alive (whatever they may be). Again, this appeals not to an unchanging core or essence, but only to the continuity of biological activity.

⁸ More precisely, there must be spatiotemporal continuity of a sort that is typical of the kind of changes that the kind of object in question can undergo [Steward 2020: 51].

The van Inwagen/Olson account of persistence is interesting because it is strikingly similar to accounts of persistence preferred by process ontologists (or those who find process ontology appealing), accounts that also appeal to the causal continuity of processes (see Guay and Pradeu [2016], Dupré and Nicholson [2018], DiFrisco [2018], and Pradeu [2018]). Alexandre Guay and Thomas Pradeu [Guay and Pradeu 2016; Pradeu 2018], for example, who are tempted by process ontology, take the identity of an organism through time to be the result of the continuation of biological activity such as metabolic or immunological activity.

It might be argued, though, that, even though substance ontologists and process ontologists both appeal to the continuity of biological activity to account for the persistence of organisms, substance ontologists are still committed to Essentialism. As we saw, van Inwagen, for example, holds that an organism persists just so long as it retains the *same life*.

In response, notice, firstly, that the view that an organism persists just so long as it retains its life does not imply that an organism's life is essential to it. Rather, this implies only that an organism's life is permanent: once it has its life, it can't lose this without ceasing to exist. That is compatible, however, with an organism's coming into existence with a different life from the one that it actually has. Suppose that we ignore this, though, and assume that an organism's life, according to van Inwagen, is essential to it. If this is a version of Essentialism, then, like Wiggins's, it is relatively harmless, given that 'same life' refers simply to the continuation of biological activity, rather than to a mysterious permanent unchanging property. At any rate, if this counts as Essentialism, then many process ontologists who take processes to exist in virtue of the continuity of activity are also committed to some sort of Essentialism. Nicholson [2018: 153], for example, says that, 'for an organism, *activity is a necessary condition for existence*.'

5. Ecological Dependence

Dupré and Nicholson [2018: 20–2] claim that processes are dependent on their environment. In contrast [ibid.: 21],

[a] thing is taken to be what it is independently of the relations it enters in ... Moreover, the properties ... that determine both its boundaries and its continued existence are grounded in features that lie entirely within those boundaries.

Dupré and Nicholson point out that all living entities enter into complex interactions with entities in their environment. Aphids, for example, undergo symbiotic interactions with the bacteria *Buchnera aphidicola*, providing the aphids with amino acids [Booth 2014: 659]. Likewise, human beings are hosts to a vast number of symbiotic bacteria that are important for their metabolic and immunological functioning [Dupré and O'Malley 2009; Pradeu 2010: 256]. Given their characterisation of things as independent entities, Dupré and Nicholson [2018: 21] claim that the ubiquity of symbiotic interactions in nature 'poses major problems for an ontology of things or substances'.

What do Dupré and Nicholson mean when they say that living entities are dependent upon their environment? One suggestion is that they mean that living entities *causally* depend on their environment. No substance ontologists, however, will deny that living entities are causally dependent on their environment; this is an empirical

fact, and no account of substance denies this. The causal dependence of organisms on their environment does not, therefore, provide a reason to worry about substance ontology.

Alternatively, perhaps Dupré and Nicholson mean that living entities are dependent on their environment in a metaphysical or ontological sense. If this is what they mean, then they seem to have the Independence Account of substance in mind as their target.

It is important to note, however, that the Independence Account is only one account of substance, and that many of the other usual accounts discussed in section 2 do not take ontological independence to be a condition for substancehood. The ontological dependence of living substances on their environment, therefore, is compatible with many accounts of substance.

More importantly, though, even the Independence Account is compatible with the ecological ontological dependence of living entities. Importantly, a distinction needs to be made between *rigid* and *generic* ontological dependence [Fine 1995; Lowe 1998; Tahko and Lowe 2016]. X rigidly depends on y if and only if x could not exist without y existing. The set, {x,y,z}, for example, rigidly depends on its particular members x, y, and z, because it would not exist if any of the members did not exist [Tahko and Lowe 2016]. Similarly, the Cheshire Cat's smile rigidly depends on the Cheshire Cat. On the other hand, x generically depends upon objects of type F iff x could not exist without *some* objects of type F existing [Lowe 1998: 141]. Electricity generically depends on electrons because, whilst it does not depend on the existence of any particular electron, it would not exist without there being any electrons [Tahko and Lowe 2016].

I imagine that, when Dupré and Nicholson say that living entities depend on entities in their environment, they must mean to be talking about *generic* dependence rather than rigid dependence (if they are indeed talking about ontological dependence). It would be implausible to believe that an organism ontologically depends on any particular entity in their environment. No one thinks, for example, that an aphid is ontologically dependent on any particular bacterium.

Some philosophers of biology, however, claim that lineages are particulars or individuals [Dupré 2017], and it might be argued that, whilst aphids are not rigidly ontologically dependent on any particular bacterium, they are rigidly ontologically dependent on a particular *bacterial lineage* or are perhaps rigidly ontologically dependent on their own lineage.

Suppose that species or lineages are individuals. The view that organisms rigidly ontologically (not causally) depend on a particular lineage is controversial, and something that I take to be false. I won't argue here for this claim, but it seems implausible to me that an organism is rigidly ontologically dependent on the lineage of an entity in its environment. That is, it seems implausible that it is *metaphysically impossible* for me to exist if the lineages of entities in my environment associated with me do not exist. Put differently, it seems metaphysically possible for me to exist in a world where the lineages of entities in my environment with which I am associated do not exist, and that in this world I am associated with entirely different lineages. Furthermore, I agree with those philosophers (such as Lowe [1998: 152]) who think that organisms are not ontologically dependent on their own lineage.⁹ At any rate, I do not think

⁹In other words, I reject Kripke's [1980] necessity-of-origin thesis.

that process ontologists will want to accept that living entities are rigidly ontologically dependent on a particular lineage, (including one's own lineage) or, for that matter, on *any* entity distinct from themselves, given those theorists' gripe with Essentialism. Suppose, for example, that an aphid rigidly depends on a particular bacterial lineage. This implies that the aphid would not exist without that lineage, and hence that the lineage is essential to it. As we have seen, this is the sort of essentialist view that process ontologists want to avoid. If Dupré and Nicholson mean to be talking of ontological dependence, they must, therefore, mean *generic dependence*, and so their claim must be that, whilst processes are generically dependent, substances are generically independent.

Most independence accounts of substance, however, are understood in terms of *rigid* independence, and so are compatible with substances being generically dependent on their environment. Here are Lowe's and Gorman's accounts:

x is a substance = df x is a particular and there is no particular y such that y is not identical with x and the identity of x depends on the identity of y [Lowe 1998: 151].

x is a substance = df x is a particular, x is unified in the right way, and there is no particular y such that y is not identical with x, y is not one of x's parts, and the identity of x depends on the identity of y [Gorman 2006: 116].

Both of these accounts of substance say only that substances are rigidly independent entities, which is compatible with living entities being substances and being generically dependent on entities in their environment. These accounts are incompatible only with living entities being substances and being *rigidly* dependent on entities in their environment. No one, however, thinks that living entities are rigidly ontologically dependent on entities such as particular bacterium in their environment. As we have seen, some might think that living entities are rigidly dependent on particular lineages, but this seems implausible to me, and, given their anti-essentialism, process ontologists ought to agree. As I see it, then, the ecological dependence of living entities on their environment does not provide a reason for taking living entities to be processes rather than substances.

6. Fuzzy Boundaries

Process ontologists stress that processes have *vague* or *fuzzy* boundaries [Dupré and Nicholson 2018; Meincke 2018]. By this, they mean that there is no definite fact of the matter about when a process comes into existence, ceases to exist, or, sometimes, whether something belongs to a process as a part. There is, for example, no definite fact of the matter about when a hurricane begins, or whether some atoms around its edges are parts of it.

The vagueness of living boundaries is puzzling. Perhaps it is ontological: there is somehow vagueness *in the world* [van Inwagen 1990: 241]. Perhaps it is epistemic: there really is a determinate answer to the question of where an organism's boundaries are, but we are ignorant of the answer. Alternatively, perhaps it is linguistic: there are many candidate referents of the word 'organism' and no one has decided which one it applies to [Lewis 1986: 212]. Call the mystery of vague boundaries, 'the Problem of Vague Boundaries'. Process ontologists argue that the Problem of Vague Boundaries can be solved if organisms are processes rather than substances. Dupré and Nicholson [2018: 35] say that

the problem of vague boundaries turns out not to be a problem at all, as processes tend to lack clearly defined boundaries to begin with.

Similarly, Meincke [2018: 374] says that taking organisms to be processes

allows us to relax about vagueness. That natural processes tend to have vague boundaries goes without saying. The crucial point is that there's nothing wrong with that; ... vagueness just lies in the nature of processes.

It isn't clear, though, why taking organisms to be processes allows us to avoid the Problem of Vague Boundaries. Even if we accept that living entities are processes, it still isn't clear how we should understand their vagueness: is it ontological, epistemic, or linguistic? If it is ontological, how should we make sense of the idea of vagueness in the world? If the Problem of Vague Boundaries is a problem, then it seems that it is a problem for substance ontology and process ontology alike.

Process ontologists might argue that processes *by their very nature* have vague boundaries, and, as such, if living entities are processes, their vagueness is to be expected. Pointing out that a problem is to be expected, however, does not solve the problem or make it any less mysterious. It might be expected that living entities have vague boundaries if they are processes, but this doesn't tell us how to make sense of the vagueness.

In addition, it could equally well be argued that substances, too, by their very nature have vague boundaries, given that paradigmatic substances such as tables, cars, mountains, stones, and so on have vague boundaries. A car might have clearer boundaries than a hurricane or an instance of fermentation or an organism, but there is still no definite answer to the question of how many atoms must be taken away from it before it ceases to exist.

Process ontologists might argue that this is a reason for abandoning an ontology of substances for artefacts and non-living natural entities, too. More generally, perhaps process ontologists will argue that a condition for an entity to be a substance, unlike a process, is that it has precise boundaries, or that substances are defined such that they have vague boundaries. As I see it, though, there is no reason to think this. Of course it is possible to define 'substance' by stipulating that substances have non-vague boundaries, but none of the usual historical accounts presented in section 2 do this. It is no feature of any of these accounts that there is a definite answer to questions about where the boundaries of substances lie. They are entirely silent on this matter. There seems no reason, then, why something with vague boundaries, too, could not be neither said of, nor in, a subject (the Negative Account), ontologically independent (the Independence Account), persist through change (the Persistence Account), a bare particular (the Substratum Account), or a form-matter complex (the Form-Matter Account), and hence, a substance by all of the usual accounts. Some philosophers, such as van Inwagen [1990] are even explicit that they take substances to have vague boundaries. Vagueness, then, does not pose a particular problem for substance ontology.

7. Process Ontologists Are Only Objecting to Particular Characterisations of Substances

We have seen that the main claims that process ontologists make about the nature of living entities—temporal extension, metabolism, ecological dependence, and vague

boundaries—do not cause trouble for an ontology of substances. These claims are not only compatible with the usual historical and contemporary accounts of substance, but are often explicitly endorsed by paradigmatic substances ontologists, too. Process ontologists, therefore, have not given good reasons for abandoning an ontology of substances for the living world.

What has emerged from this discussion is that process ontologists are objecting only to specific characterisations of substances—ones that takes substances to be three dimensional, generically ontologically independent, persisting in virtue of a mysterious ‘unchanging core’, being machine-like, and having precise boundaries. Taking substances to have these features might well be untenable for understanding the living world, but, as I hope to have shown, many typical substance ontologists often do not take substances to have these features; nor are they features of the usual historical and contemporary accounts of substance, presented in section 2. Notice, therefore, that I am not arguing simply that it is possible to tinker with the concept of a substance, or to interpret accounts of substance in a way that avoids the process ontologists’ criticisms. Rather, I am arguing that the usual historical and contemporary accounts of substance, and the ways that paradigmatic substance ontologists understand substances, already avoid those criticisms.

8. What Would a Radical Processual Philosophy of Biology Look Like?

I will end the paper by considering what a processual philosophy of biology that is radically in tension with an ontology of substance might look like.

Some philosophers have argued that there are no countable processes but only *process* (see, for example, Hornsby [2012] and Crowther [2018]). They take processes to be ‘space-filling stuffs’ like gold or water, rather than particulars. Just as we cannot count how many *waters* there are, because there are no such particulars as *waters*, we cannot count how many processes there are [Steward 2013: 806]. Rather, there is only *more or less* of some process happening. There cannot, for example, be one or more fermentations, but only more or less fermentation occurring.

Taking the biological world to contain living process, rather than particular processes, would involve a radical departure from substance ontology. It would imply not merely that living entities have fuzzy boundaries, but that there are no living particulars to have boundaries at all. There would only be *living process* or stuff. This would have significant implications for a number of debates in the philosophy of biology. Consider, for example, the Problem of Biological Individuality, which is partly a question about how to count biological individuals and where their boundaries are (see Clarke [2010]). This debate would be misguided, given that there would be no biological individuals to count or to have boundaries. It would be like asking how to count waters, or asking where the boundaries of waters are. Rather than asking how to count biological individuals, or how to determine where their boundaries are, we could only ask how *much living activity or life there* is and how it is distributed.

This ‘massy’ process ontology is not a process ontology that processual philosophers of biology currently endorse. They are clear that living processes such as organisms are countable particulars (see Dupré and Nicholson [2018: 13–14]). The massy processual philosophy of biology, then, would constitute a radical departure from substance ontology, but it is yet to be defended.

It might be argued, however, that the massy processual philosophy of biology is similar to Dupré's [2012: 241] *Promiscuous Individualism*, and hence that something like it is already held by at least one process ontologist. According to Promiscuous Individualism, there are a number of equally good and legitimate ways of carving the biological world into distinct biological individuals, and how we choose to do so is dependent on our interests. This is not because the existence of biological individuals is interest-relative or a matter of convention; it is because the world is populated by a vast number of different kinds of biological individuals with different boundaries, and which ones we choose to pick out is dependent on our interests.

It seems to me, however, that, rather than being similar to Promiscuous Individualism, the massy processual view is the polar opposite view. Whilst the massy processual view takes there to be no biological individuals, Promiscuous Individualism takes there to be many. Furthermore, whilst the massy processual view holds that there are no ways that the biological world is carved into distinct individuals, Promiscuous Individualism holds that there are many ways in which it is carved into distinct individuals. I take the massy view, and therefore Promiscuous Individualism, to be opposite views.

Finally, regardless of the relation between the massy processual view and Promiscuous Individualism, it might be argued that Dupré's Promiscuous Individualism is nonetheless in tension with substance ontology. I don't see, however, why we should think this. There is no immediate reason why a substance ontologist would be prohibited from believing that there are a number of equally good, but different, ways of carving the biological world into distinct biological substances. None of the usual historical and contemporary accounts of substance, at least, are in conflict with Promiscuous Individualism. Of course, substance ontologists may want to reject Promiscuous Individualism, but this need not have anything to do with their being substance ontologists.

9. Conclusion

Process ontologists in the philosophy of biology have not provided good reasons for abandoning an ontology of substances. There is no reason why substances cannot be temporally extended, dynamic, ecologically dependent, and have vague boundaries. This is not because accounts of substance can be tweaked in order to accommodate these features; it is because they already accommodate them. Furthermore, many substance ontologists maintain that living entities do indeed have these features. The objections of process ontologists are levelled only at particular characterisations of substances—ones that take substance to be three dimensional, generically ontologically independent, persisting in virtue of an unchanging core, being machine-like, and having precise boundaries. These features do not, however, figure in the usual historical and contemporary accounts of substance, and many substance ontologists will deny that living substances have them.

With that being said, perhaps it is true that lots of talk and practice in *biology* treats living entities as if they are static, have precise boundaries and an unchanging core, and so on. Process ontologists would be right to point out that this is misleading. Addressing this shortcoming, however, does not require abandoning an ontology of substances. More needs to be said, then, if process ontologists want to show that substance ontology is inadequate for biology and the philosophy of biology. Finally, I did outline what a radically anti-substance processual philosophy of biology might

look like if it appeals to the category of massy process. Such an account of the living world, however, is yet to be defended.¹⁰

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