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ORIGINAL RESEARCH

Biological Individuality and the Foetus Problem

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Abstract
The Problem of Biological Individuality is the problem of how to count organisms. Whilst counting organisms may seem easy, the biological world is full of difficult cases such as colonial siphonophores and aspen tree groves. One of the main solutions to the Problem of Biological Individuality is the Physiological Approach. Drawing on an argument made by Eric Olson in the personal identity debate, I argue that the Physiological Approach faces a metaphysical problem - the 'Foetus Problem'. This paper illustrates how metaphysics can contribute to debates about organisms in the philosophy of biology.

Keywords Biological individuality · Identity · Parthood · Pregnancy · Philosophy of Biology · Metaphysics

1 Introduction

Whilst it may seem easy to count organisms such as human beings and dogs, the biological world is full of tricky cases. As Jack Wilson says, 'the same intuitions that allow us to count puppies and tomato plants with confidence leave us perplexed when we try to count colonial siphonophores like the Portuguese man-of-war' (Wilson, 1999: 1). The Portuguese man-of-war resembles a jellyfish and like typical organisms, it can reproduce, it has a unique and uniform genome, and its parts work together as a single functional unit. Biologists, however, have suggested that because of the unusual way that it develops, with the fertilized ovum budding off into distinct structures, it may be best understood as a colony of several distinct organisms. Plants can be difficult to count too. Whilst aspen trees appear to be distinct biological units when considered from above ground, each tree has the same genome and is con-

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nected underground by a complex root system. Should we, therefore, treat each tree as a distinct organism in its own right, or rather as organs or parts of one larger organism? Furthermore, familiar organisms like human beings are hosts to a vast number of microorganisms that are involved in many of their host's biological processes such as the immune system, metabolism, and digestion (Pradeu, 2010; Dupré & O'Malley, 2009). Despite being genetically different from us, should we treat these microorganisms as parts of us, and, therefore, take a human being along with its microbes to be a single biological unit?

The question of how to count organisms is called the *Problem of Biological Individuality* (Clarke, 2010).[1] Whilst the problem is philosophically interesting in its own right, it is particularly important for evolutionary biology where biologists are required to count distinct biological units in order to generate predictions about evolutionary processes (Clarke, 2013).[2] Biologists, for instance, measure the spread of a trait or genes in a population by counting how many distinct *organisms* have those genes or trait. We don't simply increase the frequency of our genes by growing new matter that has our genes, but do so by reproducing new *organisms* with our genes (Olson, 2020: 63).

Answers to the Problem of Biological Individuality aim to help us count organisms by providing accounts of when something counts as an organism, and of when something counts as a part of an organism (Boyle, 2020: 2400). Answers have generally taken two main approaches (Guay & Pradeu, 2016: 6): the Physiological Approach, which appeals to physiological processes such as immunological interactions, and the Evolutionary Approach, which appeals to the theory of evolution by natural selection. Almost always, philosophers of biology tend to focus on explanatory power in biology or scientific practice in answering the Problem of Biological Individuality (Sterner, 2015; DiFrisco, 2019; Waters, 2018; Pepper & Herron, 2008; Clarke, 2013).

This paper argues that metaphysics can also contribute to answering the Problem of Biological Individuality. Drawing on an argument made by Olson (1997b) in the personal identity debate, I argue that the Physiological Approach, as it is currently understood, faces a metaphysical problem which can be called the 'Foetus Problem' (FP).[3] It is less clear whether the Evolutionary Approach also faces FP, but I will provide reasons for thinking that it can avoid it. My argument, therefore, exposes a difficulty for the Physiological Approach and may also provide one reason for preferring the Evolutionary Approach. This paper joins a growing trend among philosophers who believe that metaphysics can play an important role in debates in the philosophy of biology (Guay & Pradeu, 2016; Kaiser, 2018; Haber, 2016; Oderberg, 2020; Olson, 2020; Suárez & Triviño, 2020).

[1] Following Clarke (2013), I will be using 'organism' and biological individual' interchangeably.

[2] The problem has also been taken to be important in other biological fields such as immunology (Pradeu, 2012, 2019).

[3] Olson's argument is directed at psychological accounts of personal identity, and he similarly calls the problem that these accounts face the "fetus problem" (1997b, 98).

2 Two Approaches to Biological Individuality: Physiological and Evolutionary

According to the Physiological Approach, a biological individual is a *physiological whole* - something whose parts are coordinated and work together to maintain the functioning of the whole (Wilson & Sober, 1994: 606; Dupré & O'Malley 2009; Godfrey-Smith, 2013: 25; Pradeu 2010; Wilson, 1999: 62&89; Folse & Roughgarden 2010: 449). In addition, it holds that something is a part of an organism in virtue of contributing to the functioning of the whole. The Physiological Approach attempts to solve the Problem of Biological Individuality by telling us to count Portuguese man-of-wars, aspen tree groves, and so on, as organisms only if their parts work together as a single functioning unit.

There have been two popular versions of the Physiological Approach. One version appeals to metabolic interactions and takes an organism to be a self-maintaining system whose parts constantly use and exchange of matter and energy in order to allow the organism to grow, develop, and maintain itself (Godfrey-Smith, 2013; Dupré & O'Malley, 2009). It holds that something is a part of an organism by virtue of being involved in its metabolic activity. Perhaps surprisingly, given the metabolic integration of a human being and its symbiotic bacteria, the metabolic account has been said to entail that gut bacteria are parts of their host human organism, or put differently, that a human being, along with its symbiotic bacteria, should be counted as a single biological unit (Booth, 2014; Dupré & O'Malley, 2009; Godfrey-Smith, 2013).

The metabolic version of the Physiological Approach has been criticised by a number of philosophers of biology for being too vague to allow us to count organisms (Pradeu, 2010; 252; Godfrey-Smith 2013: 25; Clarke 2020). The main problem is that it is not clear which interactions count as *metabolic* in the required sense. A flame, for instance, is a good example of a self-maintaining system, constantly consuming energy to grow and develop (Campbell, 2015: 150). Furthermore, an obvious example of a self-maintaining in exchanges of matter and energy is the entire biosphere (Campbell, 2015: 148–149).[4]

More promisingly, some philosophers have tried to provide a precise version of the Physiological Approach by appealing to immunological activity (Pradeu, 2010, 2012; Tauber, 1994). Pradeu (2012, 2010) takes an organism is something whose parts are unified by immunological interactions. Specifically, an organism is something whose parts are related by strong biochemical interactions and 'controlled by systemic immune interactions that repeat constantly at the same medium intensity' (Pradeu, 2010: 258). Pradeu specifies that the immune interactions must be of a medium intensity - understood in terms of the strength of binding between an immune cell receptor and another entity - because if they are too strong, the latter entity will not be tolerated (Pradeu, 2010: 257). We can abbreviate the immunological account by saying that an organism is something whose parts are *immunologically related* (or perhaps more precisely, something whose parts are *maximally* immunologically

[4] Gaia theorists (Lovelock & Margulis, 1974) take the thesis that the earth or its biosphere is an organism (or at least, organism-like) seriously, but this isn't a very popular view.

related, but more on this in the next section).[5] In addition, the immunological account holds that something is a part of an organism only if it is immunologically related with other parts of the organism. As with the metabolic account, it seems to follow from the immunological account that many gut bacteria are parts of their human host given that they interact with, and are tolerated by, their host's immune system (Pradeu, 2012: 247).

I take the immunological version of the Physiological Approach to be the more promising of the two versions discussed here, given the vagueness worry facing the metabolic version.[6] As such, in the remainder of the paper, for the most part, I will set the metabolic version aside and focus on the immunological version.

The second main approach to biological individuality is the *Evolutionary Approach*, which appeals to the theory of evolution by natural selection to determine whether something counts as an organism. According to this approach, an organism is a *unit of selection* - something that is able to participate in evolution by natural selection. There are a number of versions of the Evolutionary Approach (Godfrey-Smith, 2013; Clarke, 2013; Janzen, 1977). According to Clarke (2013), organisms are things with mechanisms that provide them with the capacity to participate in evolutionary processes. These mechanisms include having a bottleneck lifecycle, a distinction between sex and somatic cells, an immune system, skin or cell walls, and pre-programmed cell death. These mechanisms are important for limiting evolutionary conflict between the parts of an organism, as well as increasing the likelihood that organisms will participate in evolutionary processes (Clarke, 2013). Similarly, Godfrey-Smith (2013) take organisms (at least multicellular organisms) to be reproducers that can participate in evolution by natural selection by virtue of having three features: (1) a distinction between sex and somatic cells (2) are descended from a bottleneck, and (3) functional integration of parts.

In contrast to the Physiological Approach, the Evolutionary Approach (or, at least, many versions of it) holds that gut bacteria are not parts of a human being.[7] This is because a human organism and its gut bacteria do not respond to natural selection as a single unit. As biologists might say, a human being and its gut bacteria have different *evolutionary fates* (Dupré, 2020: 154). My lineage, for instance could enjoy evolutionary success whilst the bacteria's lineage does not or, vice versa, because there is no mechanism guaranteeing that the gut bacteria inside a particular human being will be passed on to the human being's offspring. The bacteria and their offspring, therefore, could be passed from host to host without the hosts belonging to the same lineage. The organisms of my evolutionary lineage, therefore, could entirely cease to exist whilst the bacteria inside of me and their offspring continue to thrive in other hosts. As Godfrey-Smith (2013: 29) puts it, a human organism and their gut bacteria do not form parent-offspring lineages.[8]

[5] I borrow this phrase from Olson (2020, 76).

[6] I am, however, open to the possibility of a more precise metabolic account being presented in the future.

[7] Although, some philosophers disagree. See Dupré & O'Malley (2009: 13), Zilber-Rosenberg & Rosenberg (2008: 723).

[8] This isn't the case for all host-microorganism relations. Aphids, for example, are inhabited by the bacteria Buchnera *aphidicola*, which are transmitted vertically from parent to offspring via the cytoplasm of

We can see, then, that it makes a difference whether we adopt the Physiological Approach or the Evolutionary Approach, given that they count organisms and their parts differently. The Physiological Approach, for instance, takes a human being, along with its symbiotic gut bacteria, to belong to a single biological unit, whilst the Evolutionary Approach does not.

3 The Physiological Approach and the Foetus Problem

The Physiological Approach faces the following metaphysical problem:

Step 1. It seems to follow from the Physiological Approach that a foetus is not simply *contained* by a maternal organism, like an apple in a fridge or a metal coin swallowed by a toddler, but is a *part* of her. Kingma (2019: 628–629; 2020: 208–209), who has recently argued that pregnancy provides an interesting case study for the Problem of Biological Individuality, argues that this is strongly suggested by both the metabolic and immunological versions of the Physiological Approach. Whether she is right that this follows from the metabolic version is hard to say, owing to its vagueness (as discussed in the previous section). It does, however, seem to follow from the immunological version. Whilst a foetus is genetically different from its mother, in most cases it directly interacts with, and is tolerated by, its mother's immune system (Pradeu, 2012: 112; Howes 2007: 195; Pradeu 2010: 256). The details of foetal-maternal tolerance are complex,[9] but importantly, it involves a foetus undergoing strong biochemical interactions and medium intensity immune interactions with parts of its mother. A foetus, therefore, counts as a part of its mother according to the immunological version of the Physiological Approach.

It might instead be thought that the correct implication of the Physiological Approach is not that a foetus is a part of its mother, but that a foetus, along with its mother, are parts of a *third* organism which we might call a 'foetal-maternal holobiont' (Takeshita, 2017; Gilbert, 2014). A foetal-maternal holobiont is not the same organism as a maternal organism or a foetus, but it has them as parts.

It doesn't matter for present purposes whether this is right implication of the Physiological Approach. My argument only requires than a foetus is a part of *some* organism. As such, if you think that the correct implication of Physiological Approach is that a foetus is a part of a foetal-maternal holobiont rather that its mother, simply substitute my claim that a foetus is a part of its mother (according to Physiological Approach) with the claim that a foetus is a part of a foetal-maternal holobiont.

Step 2. If the Physiological Approach is true, then depending on how it is understood, either a foetus is not an organism *during any stage of pregnancy*, or there is at least a stage of foetal development when a foetus is not an organism.

Why should we think that if the Physiological Approach is true, then a foetus is not an organism during any stage of pregnancy? Well, some philosophers take the Physiological Approach to come with what Godfrey-Smith calls an "exclusion principle" which states that organisms cannot have parts that are themselves organ-

maternal eggs (Booth, 2014: 659).

[9] See Pradeu (2012: 111–115 &174) for the biological details.

isms (Godfrey-Smith, 2013: 26). I will from now on refer to this as the 'Exclusion Principle'.[10] These philosophers take a physiological whole to be something whose parts are *maximally* physiologically (for instance, immunologically) related - something whose parts are physiologically related, but which is not a part of some larger thing whose parts are physiologically related. The idea is that a physiological whole is the largest thing in a hierarchy of things that are related by part-whole relations whose parts are physiologically related. Consider a cell that is a part of a human being. Whilst its parts are physiologically related because it has its own immune system, it is also part of some larger thing with an immune system – a human being – whose parts are physiologically related. The thought, then, is that the cell, unlike the entire human being, is not the physiological *whole*, but merely a part of that whole. And what goes for cells also goes for the other parts of organisms too. Therefore, if a foetus is a part of its mother, and assuming that mothers are organisms, then by the Exclusion Principle, a foetus is not an organism.

A number of proponents of the Physiological Approach seem to accept the Exclusion Principle. Pradeu considers whether a colony of insects, such as a hive of bees, counts as a single organism with the individual insects of the colony as parts. Given the presence of immune activity at the colony level in some colonies, Pradeu says that this 'may imply that, in those cases, the "organism" is the colony, *rather than each insect'* (2012: 252).[11] Queller & Strassmann (2009: 3144) also seem to endorse the Exclusion Principle when they say that 'the organism is the largest unit of near-unanimous design'.[12] Consider that biological things can be ordered in hierarchies based on part-whole relations. For instance, in a particular hierarchy containing a human being, the order might be particles, genes, cells, a human being, and perhaps the species homo sapiens at the top. Queller's and Strassmann's idea is that the organism is the largest member of the hierarchy whose parts are highly cooperative. Notice that there can only be one candidate for being *the largest member*, which rules out the parts of organisms from being organisms.

It is also worth noting that some philosophers find it convincing that even if an organism can be a part of another organism, an organism cannot be part of an organism *of the same kind* (Kingma, 2018: 175). If this is correct, this would presumably rule out a foetus from being an organism if it is a part of its mother because if a foetus were an organism, it would presumably be an organism of the same kind as its mother.

Not all proponents of the Physiological Approach, however, accept the Exclusion Principle. Godfrey-Smith (2013: 26–27) is tempted by it but in the end seems to go for a "gradient approach", according to which organisms can have parts that are also

[10] The Exclusion Principle has been popular in metaphysics. See, for example, Oderberg (2020: 23) and Hoffman & Rosenkrantz (1997: 93–4).

[11] Italics are mine.

[12] Two points should be made about Queller and Strassmann's view. Firstly, it is not entirely clear whether to characterise their account of individuality as a version of the Physiological Approach or the Evolutionary Approach. This is because it characterises organisms as functionally integrated wholes, but understands this in terms of the outcome of natural selection. Secondly, as Godfrey-Smith (2013: 26) points out, Queller and Strassmann in the very same paper (2009: 3144), and in another, (2016, 869) also seem to reject the Exclusion Principle.

organisms to a lesser or higher degree than the organism they are part of. It might be thought, for instance, that the cells that make up human organisms are themselves organisms, although to a lesser degree than human organisms, or that a Portuguese man-of-war or ant colony are organisms to a lesser degree than the organisms that make them up. The proponent of the Physiological Approach might argue, then, that despite a foetus being a part of its mother, it is still an organism, albeit to a lesser degree than its mother.

Nonetheless, even if this is true, by the Physiological Approach (at least if it is understood immunologically), there will still be a stage of pregnancy when a foetus is not an organism *to any degree*. This is because a foetus' immune system develops gradually and is still premature even when the baby is born. Research suggests that the human lymphatic system is in place by eight weeks of gestation but remains immature for some time (McGovern et al., 2017: 3). Furthermore, many types of immune cell are not present in foetuses until a few weeks into the gestational period, and often take some time to mature. T cells and Natural Killer cells, for instance, have been found in foetuses only as early as 8–9 weeks into the gestational period, (Ledford, 2017), and T-cell maturation only occurs between 8 and 12 weeks of gestation (Zhivaki & Lo-Man, 2017: 586). Dendritic cells, which are crucial for targeting foreign entities for destruction, have been detected in human fetal skin as early as 9 weeks of gestation (Zhivaki & Lo-Man, 2017: 568), but have only been found to be functional by 13 weeks of gestation (Ledford, 2017).

Given this, whilst a zygote may have its own immune system, and the individual cells of the early multicellular foetus may have their own immune systems, it seems that there will be some time during the early gestational period when the foetus *as a whole* lacks the degree of immune activity necessary for it to be an organism *to any degree*. According to the immunological account, an organism probably did not emerge until 8–13 weeks of the gestational period. There need be no precise point when the organism emerges, but there certainly was not an organism there from conception.

As such, depending on how the Physiological Approach is understood, either a foetus is not an organism at any stage during pregnancy (if one adopts the Exclusion Principle), or there is at least a period of foetal development when a foetus is not an organism to any degree. Either way, according to the Physiological Approach, there is a stage when a foetus is not an organism.

Step 3. But if a foetus is not an organism during any stage of pregnancy, (if the Exclusion Principle is accepted), then a foetus never becomes an organism. Similarly, if a foetus is an organism at some stage of pregnancy, but there is nonetheless an early stage of pregnancy when a foetus is not an organism (if we accept the gradient approach), then an early non-organism foetus never becomes an organism.

Why think this? Well, almost all metaphysicians (or at least many of them) think that nothing could be an organism for only part of its existence – no non-organism could become an organism and no organism could become a non-organism (Olson 1997a: 136; 2007: 27; Blatti 2020; Van Inwagen, 1990: 145; Snowdon 1991: 111;

Hoffman & Rosenkrantz 1997: 157; Wilson1999: 99–101). Call this principle the 'Permanence Principle'.[13]

Why accept the Permanence Principle? Why not hold, for instance, that a non-organism foetus can become an organism? Firstly, I think that a number of philosophers of biology will want to accept it. This is because the Problem of Biological Individuality is often taken to partly be a question about what it takes for organisms to *persist* (Godfrey-Smith, 2016; Huneman, 2020; Pradeu, 2016; Wilson 1999). Whilst philosophers of biology are often concerned with counting biological individuals at a time, there are also questions about counting biological individuals *through time*. Consider an amoeba that divides into two distinct cells. Is this a case of two new offspring individuals coming into existence and replacing the parent individual, or is it simply a case of the original amoeba getting bigger, now being composed of two cells? Or consider metamorphosis such as the transition of a caterpillar into a butterfly. Does this event involve only one individual – the very same individual is first a caterpillar and then a butterfly – or does it involve two individuals – the caterpillar individual ceases to exist and is replaced by a distinct butterfly individual? (Wilson, 1999: 7–8 & 100). In order to answer these questions, we need to know what it takes for organisms to persist. Pradeu (2012: 237–238) actually claims that one of the main attractions of the Physiological Approach is that it does a good job of explaining how organisms persist through time. He argues that it follows from his immunological version of the Physiological Account that the persistence of organisms through time is a matter of the continuation of their immunological and biochemical activity (Pradeu, 2010: 260; 2018:106). The idea is that I am identical to an organism existing at some time in the past because if you were to follow the immunological activity of that organism through time to this present moment, you would find that it has been occurring continuously and that it is now occurring in me.

The Problem of Biological Individuality, then, is (partly) a question about what it takes for organisms to persist. Presumably, though, it is a question about what it takes for organisms to persist as opposed to what it takes for *non-organisms* to persist. As such, the accounts of organismic persistence that philosophers of biology provide won't apply to non-organisms. This can be demonstrated with Pradeu's account, which as we have seen, is tied to his immunological account of when something counts as an organism: if x and y are identical by virtue of being causally connected by the relevant biochemical interactions for something to classify as an organism - biochemical and immunological interactions - then presumably x and y must both be organisms.

Suppose then that some things such as foetuses (or early foetuses) are not organisms (as the Physiological Approach holds). If what I have said is true, then accounts of what it takes for organisms to persist won't apply to them – these accounts will take foetuses and organisms to have different persistence conditions. And if two things at different times have different persistence conditions, then they must be *non-identical.*

[13] The Permanence Principle is not the stronger view that organisms are *essentially* organisms – if organisms cannot be organisms temporarily, it still may have been the case that a particular fish was a slice of cheese. What the Permanence Principle rules out is something coming into existence as a fish and later becoming a slice of cheese.

This is because a thing's persistence conditions are supposed to apply to it throughout *all* of its career, and if a thing existing at an earlier time and a thing existing at a later time were to have distinct persistence conditions but be identical, it would be possible for a thing to change its persistence conditions partway through its career (Olson 1997a: 29 & 84). Given this, if a foetus and the later organism that develops from it have distinct persistence conditions, then they must be non-identical. As such, a non-organism foetus could not become an organism.

If this is right, this demonstrates that if proponents of the Physiological Approach are concerned with what it takes for organisms to persist, and their accounts are closely tied to their accounts of when something counts as an organism (as Pradeu's version of the Physiological Approach is), they will not want to hold that foetuses can become organisms, and more generally, that any non-organism can become an organism. They will therefore not want to reject the Permanence Principle.

Secondly, if we rejected the Permanence, Principle, it might be argued that it would not be clear what it takes for organisms to persist and how to track them through time. Why is this? Well, some philosophers have argued that each object is associated with a *substance sortal* - a kind or a concept which tells us what kind of thing a thing is in the most basic or fundamental sense (Wiggins, 1980). Importantly, substance sortals are supposed to determine the *persistence conditions* of things that fall under them, and so apply to a thing for as long as it exists (Wiggins, 1980). 'Organism' is typically taken to be a substance sortal. Suppose, though, that organisms are only organisms temporarily, and, therefore, that 'organism' is a not a substance sortal. What substance sortal would organism's and soon-to-be organisms fall under? This is not clear. It might be argued that the appropriate sortal is 'biological object'. Like 'material object', however, this seems much too general to provide persistence conditions for objects, and, therefore, to be a substance sortal.[14] Given this, since substance sortals are supposed to specify a thing's persistence conditions, it would not be clear what it takes for organisms (and soon-to-be -organisms) to persist, and so it would not be clear how to count or track organisms over time. This would be bad news for philosophers of biology interested in the Problem of Biological Individuality.

Suppose, though, that I am wrong about all of this. Even if it is not incoherent for philosophers of biology to hold that something can be an organism temporarily, such as being a non-organism and then becoming an organism, this view raises some difficult questions. Firstly, if an organism was once a non-organism, then what sort of living thing was it before it was an organism? Secondly, when an organism was a non-organism, where did its spatial boundaries lie then? If, for example, a foetus is not an organism, should we say that the placenta is a part of it, or do a foetus' boundaries only extend as far as its umbilical cord? [15]Thirdly, if a non-organism can become an organism, can it then become a non-organism again?

These questions don't have obvious answers. In contrast, if organisms are organisms permanently, we can know what kind of living thing organisms are at any stage of their career, we can consult accounts of biological individuality to determine where

[14] Samir Okasha has similarly argued that 'biological individual' is too general to be a sortal concept at a workshop at the University of Southampton (2020) on biological individuality.

[15] See Kingma (2018), who considers where the spatial boundaries of a foetus are.

their spatial boundaries are at any time of their existence, and we can be certain that organisms cease to exist when they cease to be organisms.

I think, then, that there is a good case for accepting the Permanence Principle, particularly if one is a philosopher of biology who is interested in counting organisms and determining their spatial boundaries.[16] Suppose, then, that the Permanence Principle is true and, therefore, that no non-organism can become an organism. If foetuses or early foetuses are not organisms (as the Physiological Approach holds), then it follows that they never become organisms. For the same reasons, organisms were never non-organism foetuses. If the Physiological Approach comes with the Exclusion Principle, organisms only come into existence at birth when a foetus ceases to be a part of its mother.[17]Alternatively, if the Physiological Approach does not come with the Exclusion Principle, since early foetuses would nonetheless not count as organisms, then organisms do not come into existence until some weeks or months into the gestational period when a sufficiently mature immune system emerges.

This alone is a reason to worry about the Physiological Approach – surely if we know anything, we know that a foetus is numerically one and the same thing as a later infant organism (Kingma, 2018: 178). That organisms began their lives as foetuses inside a womb seems to be common knowledge and is assumed by medical professionals and biologists.

Step 4. Importantly, though, given that the Physiological Approach holds that foetuses or early foetuses never become organisms, it faces a difficult question: what happens to foetuses or early foetuses, when organisms come into existence?

Consider first the version of the Physiological Approach that comes with the Exclusion Principle, and, therefore, holds that foetuses are not organisms. Combined with the Permanence Principle, this implies that foetuses never become organisms – if they were to become organisms, something could be an organism temporarily, which is incompatible with the Permanence Principle. What, then, happens to foetuses when organisms come into existence at birth? What is certain is that if the Physiological Approach and the Permanence Principle are true, they never become organisms. There seem to be two options, but each are problematic.

Firstly, perhaps at birth, foetuses cease to exist and are replaced by organisms (Olson 1997b: 100). More specifically, the matter that composes a foetus ceases to compose it and comes to compose a new thing – the organism (Kingma, 2018: 175–176). This option would certainly be very sad and surprising. It would imply that mothers will never get to hold the being that spent 9 months in their womb, and that the process of pregnancy inevitably involves the destruction of a foetus.

[16] Rejecting the Permanence Principle may be less problematic if one was to adopt some version of process ontology or an ontology of temporal parts. Such a person might argue that the very same living entity has a "non-organism temporal part" and a later "organism temporal part". They could say, then, that a living entity is first a non-organism and then an organism, but only in the sense of having differing parts. A discussion of process ontology and an ontology of temporal parts is beyond the scope of this paper, but it is worth pointing out that they are metaphysically controversial. See, for example, Olson (2007: ch5), for why four dimensionalism about material objects is controversial, and Morgan (forthcoming) and Steward (2020) for why process ontology in the philosophy of biology may be unmotivated.

[17] Kingma (2018:175) calls this the 'beginning at birth' view.

More importantly, though, this option isn't just sad, but is problematic. Firstly, it doesn't answer the worry that it just seems obvious that a foetus is numerically one and the same thing as the later baby organism. Secondly, whilst it might be plausible that causing something to *lose* its physiological complexity could cause it to cease to exist, it is less plausible that *increasing* something's physiological complexity – causing it to become something whose parts are maximally physiologically related – is the sort of thing that can cause something to cease to exist. We normally expect living things to die or cease to exist by decaying or losing functional capacities; not by gaining them.[18]I take this first option, therefore, to be unconvincing.

The second possibility is that when organisms come into existence at birth, foetuses continue to exist but come to share all of their matter with an organism (Olson 1997b: 100). The idea is that at birth, the matter that composes the foetus continues to compose the foetus and starts to compose a numerically distinct being – the organism - simultaneously. Therefore, after birth, where we thought there was just one living thing, there are actually two – the organism, and the being that was once a foetus. To capture this idea, we can say that according to this view, the organism and the ex-foetus are *entirely co-located*. The view that distinct material objects can be entirely co-located might seem strange, but it has been reasonably popular among metaphysicians (Baker, 2000; Wiggins, 1968; Thomasson, 2007). It has been said, for instance, that a statue and the lump of matter of which it is made are distinct but entirely co-located objects.

But even those who think that there can be entirely co-located objects do not think that there can be entirely co-located objects *of the same kind* (Olson 1997b: 101; Wiggins 1967). As such, if the ex-foetus is co-located with an organism, it cannot itself be an organism. In any event, it follows from the Permanence Principle that the ex-foetus could not be an organism. The ex-foetus, however, would be *physically indistinguishable* from an organism since it would be composed of the same matter, arranged in the exact same way, as the organism. In particular, the ex-foetuses, like an organism, would be a *physiological whole* but without being an organism. The Physiological Approach, though, precisely tells us that to be an organism *just is* to be a physiological whole. The co-location response, then, rather than allowing the Physiological Approach to avoid FP, implies that the Physiological Approach is false.

The version of the Physiological Approach that accepts the Exclusion Principle, therefore, faces a difficult metaphysical question, which I am calling the Foetus Problem (FP). But what about the version of the Physiological Approach that rejects the Exclusion Principle, such as Godfrey-Smith's gradient approach? Does this also face FP?

It seems to me that is does, and that it faces a particularly worrying version of FP. As we saw, whilst this version of the Physiological Approach does not rule out the parts of organisms from being organisms, there will nonetheless, according to this view, be a stage of foetal development when a foetus is not an organism (to any degree). I suggested that by immunological criteria, an organism probably does not appear until around 8–13 weeks of the gestational period (it could be later or earlier, but the organism was not there from conception). Suppose this is true. What hap-

[18] See Olson (1997b: 101) for a similar line of reasoning.

pened to the non-organism foetus that existed during the first couple of months or so of pregnancy? If the Permanence Principle is true, whatever happened to it, it did not become an organism. The only options seem to be that it ceased to exist, or it continued to exist as a non-organism entirely co-located with an organism, but we have already seen that both of these options are problematic.

This version of FP would be particularly worrying because it would imply that every pregnant organism, despite what we ordinarily think, is actually pregnant with two foetuses – one non-organism foetus that came into existence around the start of pregnancy, and one organism foetus that came into existence around the second or third month of pregnancy. It is hard to believe, though, that every process of pregnancy, excluding twinning, involves the creation of at least two foetuses.

Mammalian pregnancy, therefore, presents the Physiological Approach – both the version that accepts the Exclusion Principle and the version that rejects it - with a metaphysical problem. I think, however, that my argument can be extended from pregnancy to other biological phenomena too, such as hydrozoan budding (Hull, 1978). In hydrozoan budding, a part P, of an organism O, buds off and forms a new organism N whilst O continues to exist. If P is not an organism prior to budding, and organisms cannot be organisms temporarily, then P is not identical to the later organism N. We can therefore ask what happens to P when N comes into existence. If the Permanence Principle is true, then one thing is for sure, P never becomes an organism. FP, therefore, can be extended to biological cases other than mammalian pregnancy.

My argument draws on Olson's (1997b) argument against psychological accounts of personal identity. It is beyond the scope of this paper to consider Olson's argument in detail, but in short, Olson argues that psychological accounts of personal identity imply that we – human persons – were never foetuses but came into existence sometime after birth when mental capacities such as a first-person perspective or self-awareness emerge. Proponents of psychological accounts of personal identity, therefore, similarly to proponents of the Physiological Approach to biological individuality, face the question of what happens to foetuses when *we* come into existence. Interestingly, then, my argument shows that issues about personal identity in metaphysics are relevant to debates about organisms in the philosophy of biology.

Does the Evolutionary Approach also face FP? This is not so clear, and will probably depend on which version approach is adopted. There are, however, some reasons for thinking that it avoids FP. In particular, there are reasons for thinking that a foetus is a unit of selection, even in the early stages of its development. Consider Clarke's version of the Evolutionary Approach, which takes an organism to be something that possesses mechanisms for participating in natural selection (Clarke, 2013). Whilst a foetus may be lacking some mechanisms for participating in natural selection such as gamete maturation and a proper functioning immune system to control genetic variation, some of these mechanisms are already in place, such as having its own genome, being descended from a bottleneck, having its own germ-line, (Grose, 2020: 1053–1054) and having mechanisms for inhibiting mutations. Furthermore, some of these mechanisms (such as being descended from a bottleneck, and having mechanisms for inhibiting mutations), are present in zygotes, and so are present right at the start of development. There are, therefore, reasons for thinking that zygotes and

foetuses are units of selection, and, so are organisms according to the Evolutionary Approach. More, however, needs to be said about this. It may be that by other versions of the Evolutionary Approach, such as David Hull's (1980) 'interactors and replicators' view, foetuses and zygotes do not count as organisms. At any rate, it is clear that the Physiological Approach faces FP.

In the remainder of the paper, I will consider a response to my argument. For simplicity, the discussion will mostly be about the version of the Physiological Approach that accepts the Exclusion Principle. What I say, however, can easily be modified to apply to the version of the Physiological Approach that rejects the principle.

4 Response: Pluralism about Biological Individuality

It might be thought that proponents of the Physiological Approach who also accept *pluralism about biological individuality* can avoid FP. From now on, I will simply call this 'Pluralism'. According to Pluralism, or at least one version of it, both the Physiological Approach and the Evolutionary Approach are correct. More specifically, pluralists hold that each approach picks out a distinct kind of biological individual – the Physiological Approach is about biological individuals that are physiological wholes whilst the Evolutionary Approach is about biological individuals that are units of selection. Viruses, for instance, have been said to be Evolutionary Individuals given their ability to reproduce, but they are not Physiological individuals because they lack metabolic activity (Godfrey-Smith, 2013: 28).[19]Pluralism is in fact the norm among philosophers of biology,[20]and some philosophers, such as Wilson (1999) and DiFrisco (2019), take there to be many more kinds of biological individuals than Physiological and Evolutionary individuals. For simplicity, however, I will focus on the sparsest version of Pluralism which takes there to be two only two kinds of biological individual.

Notice that Evolutionary individuals and Physiological individuals must be numerically distinct. One reason for this is because they often have different parts and parthood conditions. Consider a human being. If this is a Physiological individual, then given what was said in Sect. 2, its gut bacteria are parts of it. On the other hand, if a human being is an Evolutionary individual, then its gut bacteria are not parts of it. A human being, therefore, could not be both an Evolutionary individual and a Physiological individual; otherwise it would both have and lack its gut bacteria as parts, which is impossible. More generally, no Physiological individual could be an Evolutionary individual, vice versa. This is Wilson's (1999) view. Wilson argues that in a region where a human being is located, there are at least two distinct but overlapping biological individuals (an Evolutionary individual and a Physiological individual) which share much of their matter. Wilson's pluralism, therefore, has much in common with the co-location view discussed in Sect. 3. It differs from the co-location view, however, because it does not take the overlapping individuals to have *all* of

[19] Although, see Dupré & O'Malley (2009: 7) who disagree.

[20] See, for instance, Godfrey-Smith (2013); Pradeu (2016; Wilson, (1999); Sterner (2015)), and Difrisco, (2019).

their matter in common – as we have seen, gut bacteria are parts of the Physiological individual, for instance, but are not parts of the Evolutionary individual. Notice also that the Physiological individual and the Evolutionary individual come into existence at different times. The Evolutionary individual comes into existence as a foetus, whilst the Physiological individual comes into existence sometime after birth when a physiological whole emerges (or if the Exclusion Principle is denied, a few weeks into development when the immune system is sufficiently mature).

With this distinction between Physiological individuals and Evolutionary individuals, the proponent of the Physiological Approach who accepts Pluralism can respond to FP as follows: a foetus is an Evolutionary individual, and (hopefully) survives birth long into adulthood. Sometime after birth, however, a Physiological individual comes into existence, coming to share much of its matter with the Evolutionary individual that was once a foetus. FP is therefore avoided because we need not say that at birth, foetuses cease to exist or become entirely co-located with an organism. Rather at birth, foetuses continue to exist, coming to share much of their matter with a Physiological individual.

This is probably the best solution for proponents of the Physiological Approach to avoid FP. Furthermore, as I said, Pluralism is also already widely accepted among philosophers of biology. Pluralism, however, has a worrying consequence. Assuming that *we* are biological individuals (Olson, 1997a; Snowdon, 2014), it implies that we could never know what kind of biological individual we are. Why is this? Well, according to Pluralism, where we thought there was only one biological individual, there are at least two, who share much of their matter in common. How then could I ever know whether I am the Evolutionary individual that began its life as a foetus, or the Physiological individual that began its life at birth?[21] It seems we could never know. It doesn't help to say that I am whichever biological individual is currently writing this paper, or yawning, or thinking about what is for dinner. I cannot determine which biological individual I am by focussing on what actions I am performing, and then considering which biological individual is also performing those actions because whenever I type, yawn, or have a certain thought and so on, presumably, given that they share much of their matter in common, so do both a Physiological individual and an Evolutionary individual.

It follows from Pluralism, then, that we could never know what kind of biological individual we are. As such, if Pluralism is true, we could never know when we came into existence – if we are Evolutionary individuals, we came into existence before birth, but if we are Physiological individuals, we came into existence after birth. We could also never know whether our gut bacteria are parts of us. Furthermore, whilst it seems clear that a foetus is a part of its mother according to the Physiological Approach, it is much less clear whether this is the case according to the Evolutionary Approach (Kingma 2020: 1043–1044). Given this, if Pluralism is true, pregnant mothers cannot be sure whether foetuses are parts of them. We can also never be sure whether we were once parts of our mothers.

[21] See Olson (2001) who has also noticed that Pluralism seems to imply that we can never know what individual we are.

I take this implication of pluralism to be a serious one because one reason for caring about the Problem of Biological Individuality in the first place is because answers to it would ideally help us to understand what sorts of beings *we* are (Clarke, 2010: 313).

5 Conclusion

I have provided an argument against the Physiological Approach to biological individuality. I believe that the argument shows that the Physiological Approach, as it is currently understood, does not adequately account for the process of pregnancy, and perhaps also phenomena such as hydrozoan splitting. I do not take my argument to be conclusive. It could be that there is a version of the Physiological Approach that is not vague and avoids FP. It might be that the benefits of accepting the Physiological Approach in the biological sciences outweigh the metaphysical problems it faces. Or perhaps philosophers of biology will not be particularly worried that Pluralism implies that we could never know what kind of biological individual we are. At the very least, however, I hope to have shown that there are underlying metaphysical principles, such as the Exclusion Principle and the Permanence Principle, which need to be taken into account when constructing accounts of biological individuality, and I hope to have highlighted what problems may follow if certain metaphysical principles are accepted. If philosophers of biology disagree with my arguments, I also hope to have highlighted where there may be important differences between how metaphysicians and philosophers of biology think about organisms.

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