

ORGANISMS AND THE EXTENDED SELF: A RE-EVALUATION

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Submitted to the graduate degree program in philosophy and the Graduate Faculty of
the University of Kansas in partial fulfillment of the requirements for the degree of
Master of Arts.

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Date Defended: 29 April 2016

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Date approved: 29 April 2016

Abstract

In this paper I argue against Olson (2011) who argues that the extended mind thesis must be false if animalism—the view that human persons are numerically identical with biological organisms—is true. Whilst I agree with Olson that the animalist’s approach is the best account of personal identity, I disagree with his position regarding the extended mind thesis. I argue, contrary to Olson, that understanding human beings as organisms leads to the acceptance of a version of the EST. This is important also, as it shows that one need not have any commitments to the EMT to accept the EST.

Acknowledgements

I would like to thank my defense committee for an engaging conversation, in particular, I would like to thank my committee chair, Armin, for the conversations, time, questions, draft reviews, advice, etc. without which this paper would not be nearly as clear.

Table of Contents

Abstract	iii
Acknowledgements	iv
Body	1
References.....	16

Introduction

According to Clark and Chalmers (1998) the extended mind thesis (EMT) entails the extended self thesis (EST). They write: “does the extended mind imply an extended self? It seems so. Most of us already accept that the self outstrips the boundaries of consciousness; my dispositional beliefs, for example, constitute in some deep sense part of who I am. If so, then these boundaries may also fall beyond the skin” (p. 18). Olson (2011) disagrees, arguing that EST must be false if animalism—the view that human persons are numerically identical with biological organisms—is true. Whilst I agree with Olson that the animalist’s approach is the best account of personal identity, I disagree with his position regarding the EST. I argue, contrary to Olson, that understanding human beings as organisms leads to the acceptance of a version of the EST. This is important also, as it shows that one need not have any commitments to the EMT to accept the EST.

This paper is divided as follows: in section 1, I will briefly explicate Olson’s stance on personal identity— viz., that humans are biological organisms—and show how this position leads him to argue against the EST. In section 2, I respond to Olson’s argument by elucidating some general problems of organismality (to borrow a term from Queller and Strassmann 2009). In the same section I will briefly outline several attempts at offering the conditions of organismality, each of which would entail, at least from an animalist’s point of view, some version of the EST. In section 3, I consider an objection to my argument. Section 4 concludes this paper.

1. Olson vs. the extended self

Olson (1997) argues that the psychological approach to personal identity is false.

Instead, we ought to embrace the biological approach—a non-psychological account of

personal identity according to which *biological continuity* is what determines our persistence through time. According to this account, insofar as one's purely animal functions (metabolism, the capacity to breath, the capacity to circulate one's blood, etc.) continue, the individual persists through time (1997, p. 16). More specifically, the biological approach towards personal identity makes two claims, according to Olson: (1) all people are animals, that is, we are members of the species *Homo sapiens*, and (2) psychological continuity is neither necessary nor sufficient for people (i.e. human animals) to continue to exist through time (Olson 1997, p. 16).¹

Olson further argues that accepting the biological view of personal identity leads to the rejection of the EST. To underwrite this claim, he turns to Clark and Chalmers's (1998) thought experiment of Otto, a man suffering from Alzheimer's disease. Because of his disease, Otto uses a notebook that he consistently keeps with him to write down any new information that he learns. According to Clark and Chalmers (1998), this notebook plays the usual role for Otto that would normally be played by biological memory (p. 12). Otto's notebook, then, ought to be considered an extension of Otto's self, that is, "Otto *himself*" is best regarded as an extended system, a coupling of biological organism and external resources" (Clark and Chalmers 1998, p. 18).

Olson notes further that Clark and Chalmers's argument here has an important mereological corollary: Otto the person becomes a disconnected or scattered object (Olson 2011, p. 484). In particular, if Clark and Chalmers are correct, then when Otto began using the notebook he gained new parts, getting larger, and if he were to stop using the notebook then he would lose parts, getting smaller (p. 487). This, though, leads to a significant implication:

¹ Olson does allow for the possibility of people that are not animals (e.g. gods, trolls, Martians, etc.), however, all *human* people are animals (Olson 1997, p. 17) in his view, and cannot become such non-animal people (p. 125).

Otto is not a biological organism. If he is any organism at all, he is the one we might call his body, O. There is no other organism he could be; O is the only one in the story. But Otto could not be *O*, because *O* does not get bigger when Otto takes up the notebook or smaller when he stops using it. Even if the notebook becomes a part of Otto, it always belongs to *O*'s surroundings. You can't make a biological organism bigger by getting it to use a notebook as Otto does, or smaller by taking the notebook away. So although the notebook comes to be a part of Otto (on the extended self), it never becomes a part of any organism. It follows that Otto is not an organism (Olson 2011, p. 486).

Not only is Otto not an organism, according to Olson, he never was an organism because no organism has "having a notebook as a part at some time" as a property, and one cannot be an organism but have a property that no organism has (Olson 2011, p. 486). It must be the case, then, that Otto is not *essentially* an organism. Likewise, Otto is not *accidentally* or *temporarily* an organism because no *accidental* or *temporary* organism have the property "having a notebook as a part at some time" (p. 486). In short, accepting the EST requires a denial of the biological view of personal identity—and vice-versa: accepting the biological view of personal identity requires denying the EST: if Otto is where O is, then he does not comprise the notebook—i.e. he is not extended.

Olson suggests that one way of resisting his conclusion is to suggest that when Otto uses his notebook, the notebook *does* become a part of *O*. Those that take this position, he claims, may be inspired by the doctrine of the extended phenotype, and claim that items that contribute to an organism's reproductive success are a part of the organism (Olson 2011, p. 489).

Although this position is possible to hold, Olson argues that it does not help the EST, as “even if something deserving to be called an organism does come to have Otto’s notebook as a part, there is surely also something deserving that description that never extends beyond its skin” (Olson 2011, p. 489). He calls the first entity (Otto and his notebook) the ‘extended organism’ and the second (Otto without his notebook) the ‘core organism’. A problem arises here, however, as although this would allow Otto to be an ‘extended’ organism, it would prevent him from being a ‘core’ organism because only the extended organism gets bigger when Otto uses his notebook, the ‘core’ organism does not (p. 489).

In short, organisms, according to Olson, cannot change size when objects are added/subtracted from it. Neither can organisms be spatially divided and spread out. Even if such things were possible, there would be such an entity that could exist as an “organism” despite having objects added/subtracted from it, or spatially divided from it. This leads to Olson argues that the ‘core’ organism is what really matters to personal identity, not the ‘extended’ organism.

2. The problem with organismality

Olson’s objection to the counter-argument relies on his ‘extended organism’/‘core organism’ distinction. I, however, view this distinction as problematic and unhelpful. The distinction that Olson defends tacitly understands a (core) organism as something that can be understood outside of its environmental context—outside of its developmental matrix. Olson’s account also follows a common-sense view of organismality which, as we will see later on, is problematic. This view is what Olson invokes when he states “even if the notebook becomes a part of Otto, it always belongs to

*O*s surroundings” (Olson 2011, p. 486). This claim is exactly where Olson’s argument for Otto’s not being an organism takes off, and exactly where I think it is wrong.

To fully understand why this distinction is problematic we must first understand Olson’s position on the nature of an organism. Ultimately, Olson believes that it is up to biologists to decide what an organism is (Olson 1997, p. 126)—however he does state that organisms differ from other material things in that organisms have *lives*, something other material objects do not possess. By *life*, Olson refers to a biological event that is self-organising and maintains the complex internal structure of the organism (Olson 2007, p. 28). Furthermore, Olson suggest that we should expect all living organisms to have a metabolism, teleology, and an organised complexity. It will be beneficial to look at these conditions in more detail.

We should expect all living organisms to have a metabolism, that is, they are able to retain their form and structure even though they are constantly and rapidly exchanging matter and energy with their surroundings. Indeed, Olson notes that this constant exchange the organism has with its surroundings is vital to the organisms surviving (Olson 1997, p. 127).

All living organisms will also have some form of teleology, that is, the organism’s size, shape, internal structure, chemical composition, temperature, and movement are governed from within the organism itself, only being slightly influenced by their surroundings (Olson 1997, p. 127). The parts of an organism are also connected in such a way that allow the organism to achieve its telos—they allow the organism to survive and reproduce. These parts are so closely interconnected that the entire internal structure of the organism could collapse unless nearly all of the parts are functioning properly (p. 128).

The teleological nature of organisms is grounded, according to Olson, in their complex biochemical structure. That is, organisms are made up of 10^{14} cells that are arranged in a very complex and improbable fashion, and each contain 10^{12} bits of information (Olson 1997, p. 128). These cells contain, and are arranged, by a “plan” that “instructs” the molecular parts of the organism how to repair itself, grow, develop, and building new organism like it. Olson states that the “plan” that is contained in each cell of each terrestrial organism is (in most cases) made of DNA (p. 129).

Olson’s arguments are implausible, however. I bring this out in two stages: first, I will show examples of entities we typically want to describe as organisms, but that Olson’s view would have a hard time describing as such. Second, I will show that defining “organism” is much harder than Olson’s view realizes, but that, a closer look at three possible definitions of “organism” in the literature suggests that organisms do, in fact, extend beyond the skin.

2.1. Problematic cases for Olson

Olson’s view of the nature of organisms is problematic. This is mostly due to the fact that seemingly commonsensical view that organisms are complex, adaptive, and physically integrated, with integrative parts that are physically cohesive, turns out to be biologically implausible. Three examples will bring this out clearly.

First, unlike endotherms (which have an internal heat source), ectotherms are animals which do not have a sufficient internal heating source, and who have a weak or absent physiological mechanism for retaining body heat (Davenport 1992, p. 7). Because of their poor internal heating source, many ectotherms bask to control the energetic cost of thermoregulation (p. 58). Many species of snakes and lizards, for example, bask in the sun and then hide in the shade in order to maintain a steady body temperature (p. 58-9).

For present purposes, the key point to note is that ectotherms are not classified organisms if we accept Olson's view concerning the nature of organisms. Recall that Olson's view of an organism's teleology states that an organism's temperature is mostly self-regulated, with the organism's surroundings playing a small role. In fact, Olson talks about thermoregulation in more detail stating that when the ambient temperature changes, the metabolism of an endotherm increases and the organism's blood flow is directed away from the surface to conserve heat. The organism, in this instance, is imply registering changes in its environment and reacting to those changes appropriately such that it can maintain a constant interior temperature (Olson 1997, p. 128). However, Olson never mentions ectotherms—the organisms that rely a great deal on their surroundings to regulate their body temperature. Since ectotherms rely greatly on their surroundings to regulate their body temperature due to their insufficient internal heating source, and since (according to Olson) organisms are able to maintain (with only a little help from their surroundings) their own body temperature, it must be the case that ectotherms are not organisms. Unsurprisingly, this is not a conclusion biologists have drawn.

Second, Olson also has a difficult time explaining where some symbionts reside in his 'core'/'extended' dichotomy. For instance, the intestinal habitat of an individual human contains 300-500 different species of bacteria that have evolved and adapted to live there (Guarner and Malagelada 2003, p. 512). These bacteria can offer health benefits to their host including the recovery of metabolic energy and absorbable substrates (p. 513), and the development of a competent immune system (p. 514).

More importantly (for the purpose of this paper), one mode of acquiring these bacteria is horizontal, that is, the bacteria are acquired from the environment at each generation of the host (Pradeu 2011, p. 82). This interdependency between the human and bacteria has led some (Gill et al. 2006, Salvucci 2012) to see human beings as

superorganisms. This has the interesting consequence that, contrary to Olson, the human organism (something we commonly see as a distinct, perhaps ‘core’, organism) is in fact a superorganism consisting of more than one organism, each which cannot function without the other. This sits badly with Olson’s analysis as described above.

Third, as Sterelny and Griffiths (1999) point out, the common-sense view of organisms does not describe plants well (p. 173). As Dupré (2010) notes, “to the average mushroom collector a single mushroom is an organism, and it would be strange indeed to claim that two mushrooms collected miles apart were parts of the same organism” (p. 21). Despite this intuition, however, many botanists (and some biologists in general) take precisely this view (p.21) precisely because the plasticity of plants makes it very difficult to count the number of genetic individuals (Harper 1977, p. 26). Thus, the population structure of plant communities is broken into two levels: ramets and genets. A genet is described by the number of individuals that are represented by the original zygotes (p. 26), whereas the ramet is unit of clonal growth that often break apart from the parent plant to form its own, independent existence. It is the ramet that is often the unit that is counted in the field (p. 24). Indeed, Janzen (1977) held exactly this this view, suggesting that dandelions sharing the same reproductive fitness (what he calls “evolutionary individuals” or EIs) ought to be seen as a single, perennial organism that has parts that move around, grow, divide, and die (p. 586). An interesting implication of this view is that, contrary to Olson, an organism can be spatially (and even temporally) divided. A particular EI may be scattered over a mile with different parts growing and dying at different times, whilst the EI stays the same. That is to say, an EI could have a particular dandelion as a part at time T1 and not have it as a part at T2 (and vice-versa).²

² However, as will be made clearer later in this paper, this is not the final answer either: after all, not all living things allow for a genet/ramet distinction. In fact, even generalizations of this view

Given all of this, it is reasonable to think that the account of “organismality” that Olson relies on is untenable. However, it turns out that it is quite difficult to determine precisely what the right view of organism is. Clarke (2013) notes that there are at least fifteen different possible definitions of “organism” including reproduction, spatial boundaries and contiguity, sex, adaptation, immune response, and others (p. 414-15, see also Clarke 2010 for a full list of definitions), many of which do not overlap in certain circumstances of characterization (Clarke 2010).³ This difficulty may stem from two facts discussed by Clarke and Okasha (2013): the problem of vagueness (in which the predicate ‘organism’ is simply too vague to classify borderline cases) (p. 60) and the problem of multiple criteria (which suggests the problem stems from biologists using multiple criteria when defining the categories) (p. 62). Fortunately, a detailed, specific definition of “organism” is not needed here. Instead, all that is needed is an understanding of the basic *form* of what such a definition may look like.

To achieve this understanding, it is best to briefly look at some of the key options concerning what organisms might be taken to be: developmental systems theory (DST), extended replicator theory (ERT), and the immunological criterion of organismality (ICO).

2.2. Key options concerning the nature of organisms

Instead of trying to define “organism” directly, defenders of DST focus, at least in the first instance, on “developmental systems”. However, it turns out that there are two different definitions of the “developmental system” (Pradeu 2010a): *individual* DS and

that focus on genotypes face problems: for example, Godfrey-Smith (2009) and Dupré (2010) point out that the existence of chimeras and mosaics in biology cause problems with this view.

³ Note also that others, such as Wilson (2000) argue that a clear concept of “organism” is not even necessary.

evolutionary DS. *Individual* DS is mainly supported by Oyama (particularly in 2000a, b) and is concerned with explaining the characteristics of an individual organism by examining the organism's developmental system, or, as Pradeu explains, "the explanandum [. . .] is the characteristics of an individual organism. The explanans is the *individual* DS. What does the individual DS contain? It is an *epistemological* notion: it contains all the resources that explain why this organism is as it is" (Pradeu 2010a, p. 217).

Contrasting the *individual* DS is the *evolutionary* DS, which is mainly supported by Griffiths and Gray (see Griffiths and Gray 1994), Pradeu claims, suggests the explanandum is the coevolution of organisms and their environment, not the characteristics of individual organisms (Pradeu 2010a, p. 218). This definition of DS also makes an interesting move by fusing of the organism and environment into one entity. Griffiths and Gray (1994) state "perhaps the most radical departure is that the separation of organism and environment is called into question" (p. 300), and later (Griffiths and Gray 2001) "since we claim that there is no distinction between organism and environment . . ." (p. 207).

Fortunately, it is not relevant which definition of DS turns out to be preferable. What is relevant is the interdependence of organism and environment inherent to the both definitions. On the 'weak' view offered by Oyama and others, an organism is an individual necessarily embedded and developed in a developmental system. On the 'strong' view offered by Griffiths and Gray (and others), an organism can be said to be unit of individual-plus-environment. In either case, though, an organism is necessarily understood as an entity *plus* some other entity or object in the environment.

The ERT is similar to the DST in that the environment plays a crucial developmental role in the organism, the difference being *what* aspects of the

environment play a crucial role in development. The specific differences between the two views are not important for the purposes of this paper, however their similarities are.

Sterelny, Smith, and Dickison (1996) state how the objects in an organism's environment play a role in the organism's development:

Some developmental factors do not just cause similarities between one developmental cycle and its successor. They have the form they do because they cause those similarities. These are the replicators. We do not distinguish them on the grounds that they are more important than other factors in the developmental process; rather, we distinguish them because they are adapted to play the role they do in development (Sterelny, Smith, and Dickison 1996, p. 384).

Replicators, then, are any object in the organism's environment that have been adapted to play a particular role in an organism's development. For example, the genetic makeup of an organism may lead it to dig a specific type of burrow. If such burrows are used consistently then characteristics of the burrows themselves can be seen as replicators because the effects of the burrows are being passed on from one generation to another. This replication is, however, is not genetic (Wilkins and Hull 2014, web.)

Like that of the DST, a specific understanding of an organism according to the ERT is unclear. However, due to the role parts of an organism's environment plays in its environment, whatever understanding we get in ERT must be seen as comprising the traditional biological individual plus the parts of the environment that have been adapted to play a particular role in its development.

The immunological criterion of organismality (ICO) continues this pattern of inclusion. According to this view the field of immunology can offer a theory of biological individuality (Pradeu 2010b, see also 2011, 2013). This is a necessary condition, according to its proponents, because the immune system acts as a sort of surveillance system that is able to define what is accepted and rejected by the organism. As such, the parts that constitute the organism are determined by which parts (when added) are accepted or rejected by the immune system (Pradeu 2010b, p. 253).

According to the ICO, the bacteria that form a symbiotic relationship with their host make for one example of a type of foreign entity that attach to, and become part of, an overall organism due to the immune systems acceptance of the addition (Pradeu 2011). Thus, one consequence of the ICO is that an organism is composed of endogenous parts, that is, the parts that constitute an organism are heterogeneous—organisms are composed of foreign things (Pradeu 2010b, p. 259, see also Pradeu 2011 for a more detailed argument.)

For present purposes, the key thing to note is that, on any of these theories—the DST, the ERT, and the ICO—an organism is best understood as including both an individual as well as some part of the individual’s environment. While, as made clear by Clarke and Okasha (2013, p. 313) and Clarke (2010, p. 58), we do not know how to “parcel up” certain living matter into organisms, we do know that, contrary to Olson, an organism does extend beyond its skin. After all, once we have identified how to determine the conditions of organismality it is plausible that it will go beyond the boundaries of the skin—whether to include foreign organisms such as bacteria, or to include developmental systems necessary for the survival of the organism. This is simply a feature that all currently accepted definitions of “organismality”. Therefore, we can agree with Olson that the self numerically identical with an organism, but disagree with him that selves cannot be extended.

3) An Objection

Olson may accept that the environment plays an important part in the development of the organism, but still hold the clear distinction between the organism and the environment. That is, Olson may admit that the environment is important for the *development* of an organism, but maintain that does not entail such development constitutes *part of* an organism. The organism, this argument maintains, must have a clear boundary between it and its environment.

This seems, in fact, to be supported by the same authors cited in the previous section. So, the importance of a clear boundary between organism and environment is also noted by Sterelny and Griffiths (1999): they argue for the importance of physical cohesion and boundary between the organic system and its environment on the basis that this boundary offers clear segmentations in evolutionary processes (p. 175). This physical boundary also removes direct external control over any units within its borders, which begin to interact with one another as dominate elements of one another's selective environment (p. 176).

Furthermore, Pradeu (2011) too, argues in favour of boundaries, stating "I suggest that what is needed is a new conceptualization of the organism's boundaries—a claim that clearly does not amount to saying that there is no actual distinction between the organism and it's environment" (p. 84). What Pradeu is attempting to do is avoid the conclusions that some DS theorists maintain (i.e. that there is no boundary between organism and environment). Of course, as shown above, Pradeu's solution to this task of finding a new boundary involves the immune system, however one not need accept his solution to agree with his conclusion: a *new* conceptualization of boundaries is needed.

However, this commitment to a boundary between organism and environment does not, in fact, help Olson's argument very much. This is due to the fact that a conceptualization of such a boundary need not be based on the skin of the organism. Indeed (if the discussion concerning the conditions of organismality have shown us anything), the boundary frequently does *not* start at the skin. In other words: we may agree that there must be a boundary between organism and environment, but still maintain that some entities outside of the object's skin fall *inside* this boundary.

For example, spiders digest their food outside of their body. After subduing their prey, a spider vomits digestive fluid from the intestinal tract onto the victim, and after a period of time the (now liquefied) pre-digested prey is consumed, and the process is repeated until either only an empty shell or unrecognizable mass of leftovers remain (Foelix 1996, p. 38). The processes of external digestion isn't limited to spiders; digestion in the majority of arachnids takes place externally (Barnes 1987, p. 497).

The key thing to take from the spider example is that the digestion of its prey takes place outside the skin of the organism. If we maintain that the boundary of an organism is its skin, as Olson does, then we can conclude that no spider has ever digested food. According to this view, since the digestion process does not occur inside the skin of the organism, the organism cannot be said to be the thing doing the digesting. This response is strange, especially once an important follow up question is asked: if the spider does not digest its food, then what does?

Of course, arachnologists have not concluded that spiders do not have the ability to digest their prey. Instead, as I have shown above, they conclude that the digestive processes take place outside the spider, but that the processes still belong to the

spider—they are still an ability that the organism has (see also Adams and Aizawa 2001, p. 46).⁴

4. Conclusion

In this paper I have suggested that, contrary to Olson, we ought to expect some version of the EST to be true if humans are organisms. Although defining an organism is tricky, many of the offered definitions either extend the boundaries of the organism beyond the skin, include superorganisms, or object to boundaries altogether. In this way, it becomes clear that, far from rejecting the EST, Olson should embrace it.

⁴ The case of the deep sea ceratioid anglerfish (*Cryptopsaras couesi*) may be another good example here. During reproduction, the male *Cryptopsaras* permanently attaches itself to the female *Cryptopsaras*, forming a parasitic bond which ultimately leads to the entity sharing the same circulatory system. This process creates a self-fertilising hermaphroditic organism (Pietsch 1975, p. 38). The male *Cryptopsaras* is a candidate of an entity that exists apart from the female *Cryptopsaras* at first, but once joined the male organism becomes dependent on the female to such an extent that they share parts. This particular case does not involve the abolition of a boundary, merely the re-configuration of one. That is, we can maintain that there is still a distinction between the anglerfish and its environment, however, after the male and female *Cryptopsaras* share the same circulatory system the boundary itself gets larger to encompass both entities. Whether or not we should view the male and female *Cryptopsaras* as becoming a single organism after they fuse is an interesting question, but not one I will try to answer here. Still, it remains true that this case poses a problem for Olson as it involves an organism getting bigger simply by adding parts—precisely what Olson says cannot happen. At any rate, the example in the text is sufficient to underwrite the plausibility of my response here.

References

- Adams, Fred, and Ken Aizawa. 2001. "The bounds of cognition." *Philosophical Psychology* 14 (1):43-64.
- Barnes, Robert D. 1987. *Invertebrate Zoology* 5th ed. Philadelphia: Saunders College Publishing.
- Clark, Andy, and David Chalmers. 1998. "The Extended Mind." *Analysis* 58 (1):7-19.
- Clarke, Ellen. 2010. "The Problem of Biological Individuality." *Biological Theory* 5 (4):312-325.
- Clarke, Ellen. 2013. "The Multiple Realizability of Biological Individuals " *The Journal of Philosophy* 110 (8):413-435.
- Clarke, Ellen, and Samir Okasha. 2013. "Species and Organisms." In *From Groups to Individuals: Evolution and Emerging Individuality*, edited by Frédéric Bouchard and Philippe Huneman, 55-75. Cambridge: MIT Press.
- Davenport, John. 1992. *Animal Life at Low Temperature*. New York: Chapman & Hall.
- Dupré, John. 2010. "The Polygenomic Organism." *The Sociological Review* 58:19-31.
- Foelix, Rainer F. 1996. *Biology of Spiders*. 2nd ed. New York: Oxford UP.
- Gill, Steven R., Mihai Pop, Robert T. DeBoy, Paul B. Eckburg, Peter J. Turnbaugh, Buck S. Samuel, Jeffrey I. Gordon, David A. Relman, Claire M. Fraser-Liggett, and Karen E. Nelson. 2006. "Metagenomic Analysis of the Human Distal Gut Microbiome." *Science* 312 (5778):1355-1359.
- Godfrey-Smith, Peter. 2009. *Darwinian Populations and Natural Selection*. Oxford: Oxford UP.
- Griffiths, P. E. , and R. D. Gray. 1994. "Developmental Systems and Evolutionary Explanations." *The Journal of Philosophy* 91 (6):277-304.

- Griffiths, P. E. , and R. D. Gray. 2001. "Darwinism and Developmental Systems." In *Cycles of Contingency: Developmental Systems and Evolution* edited by Susan Oyama, Paul E. Griffiths and Russell D. Gray, 194-218. Cambridge: MIT Press.
- Guarner, Francisco, and Juan-R Malagelada. 2003. "Gut flora in health and disease." *The Lancet* 360:512-519.
- Harper, John L. . 1977. *Population Biology of Plants*. London: Academic Press.
- Janzen, Daniel H. 1977. "What Are Dandelions and Aphids? ." *The American Naturalist* 111 (979):586-589.
- Olson, Eric T. 1997. *The Human Animal: Personal Identity Without Psychology*. Oxford: Oxford UP.
- Olson, Eric T. 2007. *What Are We?: A Study in Personal Ontology*. Oxford: Oxford UP.
- Olson, Eric T. 2011. "The Extended Self." *Minds & Machines* 21:481-495.
- Oyama, Susan. 2000a. *Evolution's Eye*. Durham: Duke UP.
- Oyama, Susan. 2000b. *The Ontogeny of Information*. 2nd ed. Durham: Duke UP.
Original edition, Cambridge UP, 1985.
- Pietsch, Theodore W. . 1975. "Precocious sexual parasitism in the deep sea ceratioid anglerfish, *Crypopsaras couesi* Gill." *Nature* 256:38-40.
- Pradeu, Thomas. 2010a. "The Organism in Developmental Systems Theory." *Biological Theory* 5 (3):216-222.
- Pradeu, Thomas. 2010b. "What is an Organism? An Immunological Answer." *History and Philosophy of the Life Sciences* 32 (2/3):247-267.
- Pradeu, Thomas. 2011. "A Mixed Self: The Role of Symbiosis in Development." *Biological Theory* 6 (1):80-88.
- Pradeu, Thomas. 2013. "Immunity and the Emergence of Individuality." In *From Groups to Individuals: Evolution and Emerging Individuality*, edited by Frédéric Bouchard and Philippe Huneman, 77-96. Cambridge: MIT Press.

- Queller, David C., and Joan E. Strassmann. 2009. "Beyond Society: The Evolution of Organismality " *Philosophical Transactions: Biological Sciences* 364 (1533):3143-3155.
- Salvucci, Emiliano. 2012. "Selfishness, warfare, and economics: or integration, cooperation, and biology." *Frontiers in Cellular Infection Microbiology* 2 (54):1-12.
- Sterelny, Kim, and Paul E. Griffiths. 1999. *Sex and Death*. Chicago: The University of Chicago Press.
- Sterelny, Kim, Kelly C. Smith, and Michael Dickison. 1996. "The Extended Replicator." *Biology and Philosophy* 11:377-403.
- Wilkins, John S. , and David Hull. 2014. "Replication and Reproduction." The Stanford Encyclopedia of Philosophy.
- Wilson, Jack. 2000. "Ontological Butchery: Organism Concept and Biological Generalizations." *Philosophy of Science* 67:S301-S311.