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THE LIFE AND DEATH OF ANIMALS

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Abstract

What are we, and how do we persist over time? Animalists claim that we are animals. That is a promising view that seems to accord with what science tells us. But what does it mean to say that we are animals? Animalists assume that the terms ‘animal’ or ‘human animal’ refer to fundamental kinds of thing. Actually, both refer to phylogenetic groups that are not associated with any specific persistence conditions and may not even be natural kinds. Furthermore, organisms belong contingently to their taxa, hence, we might have existed and not have been animals, if evolutionary history had gone differently. But we are necessarily organisms – living material objects that selectively exchange matter and energy with the environment and keep themselves far from thermodynamic equilibrium. This thesis presents a novel account of the metaphysical nature of organisms, the *living objects view,* based on the bound state view of composition. Organisms come into existence by inheriting functional physical structure and life processes from previously existing organisms. Multicellular organisms are *composite organisms* made of smaller *component* organisms, the cells. The life of a multicellular organism begins when, during development, an object composed of living organisms, but not itself alive (the early embryo), acquires the capacity to engage in and coordinate metabolic activities. Organisms persist over time in a distinct way from other material objects, because through metabolic activities they contribute to the maintenance of their bound states. Being essentially living objects, organisms cease to exist when they die. Once an organism dies, it cannot live again. Some organisms can, however, survive in a state of cryptobiosis with their metabolism stopped; they remain alive and continue to exist while enough of their physical structure is preserved for them to retain the capacity to resume metabolic activity under suitable conditions.

For my father

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Author’s declaration

I declare that the work in this dissertation was carried out in accordance with the requirements of the University's *Regulations and Code of Practice for Research Degree Programmes* and that it has not been submitted for any other academic award. Except where indicated by specific reference in the text, the work is the candidate's own work. Work done in collaboration with, or with the assistance of, others, is indicated as such. Any views expressed in the dissertation are those of the author.

SIGNED: Margarida Hermida DATE: 30/08/2023

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Introduction

This thesis is concerned primarily with two questions: (1) ‘What are we?’, and (2) ‘What are our persistence conditions?’. These are not idle metaphysical questions. What kind of thing we are and what persistence conditions we have determines what changes we can undergo while continuing to exist. For example, could I exist as a patient with advanced dementia, as a human organism in a vegetative state, as a brain-dead but still breathing human body, or even as a corpse? Was I ever a foetus, an embryo, or a zygote? These are not only among the most interesting metaphysical questions facing us – we naturally want to know what kind of thing we are – but finding answers to them has important practical consequences as well, as it can inform our views on difficult bioethical problems.

My goal is to identify the kind of thing we are, and subsequently to investigate the persistence conditions for things of that kind. However, the task is complicated by the fact that entities can belong to many natural kinds simultaneously, not all of which are nested hierarchically within each other, but form cross-cutting classifications (Khalidi 1998; 2013). Although some philosophers defend a form of relative identity, according to which there is no fact of the matter whether an entity persists simpliciter, but only whether the entity persists as an F, others argue that persistence consists in spatio-temporal continuity coupled with membership in a particular natural kind. It is generally thought, however, that only some natural kinds provide information about the persistence conditions of things belonging to them. These natural kinds have been variously called basic kinds, fundamental kinds, essential kinds, substance kinds, substance sortals, ultimate sortals, and persistence sortals.[1]

Although scientists do not address the metaphysical question of personal identity, the scientific consensus is that human beings are animals. Therefore, animalism is a good starting point in a metaphysical investigation of the kind of thing we are. Nevertheless, there are some problems with animalism as it has so far been presented in the literature. As presently stated, it is ambiguous as to what kind of thing we are, and it makes problematic assumptions concerning biological taxa.

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[1] I am not claiming that these concepts are equivalent, but only that they embody the same preoccupation with the persistence conditions of things which fall under the natural kinds in question.

Animalists claim that we are (identical with) animals or, more specifically, human animals (members of the species *Homo sapiens*, or perhaps of the genus *Homo*) or, more generally, organisms. I assess these different possible formulations of animalism with a view to precisifying the identity claim it makes, in a way that avoids these problems. I conclude that animalism is best stated as the view that we are organisms. The next step is to develop an account of organisms that is fully aligned with our best scientific knowledge. I argue that none of the various accounts of organismality currently on offer is adequate, and I present a new account of organisms based on a naturalistic approach to the composition of material objects. Questions regarding the persistence of organisms can then be tackled. I discuss when organisms come into existence and cease to exist, how they persist over time, and the issues raised by death and suspended animation.

A note on methodology: throughout this thesis, I assume scientific realism, and adopt a naturalistic metaphysics according to which the natural sciences are prior to metaphysics. While this commitment to naturalism places significant constraints on philosophical theorising, these constraints should be welcomed, because “philosophical theorising unconstrained by empirical fact loses its connection with the very phenomena which we, as philosophers, seek to understand” (Kornblith 2002: 27). Naturalistic or scientific metaphysics has so far focused mainly on physics, but one of its main aims is to contribute to the unification of the sciences (Ladyman & Ross 2007), of which biology is surely the most important as far as our nature is concerned. My approach in this thesis may thus be characterised as ‘naturalistic metaphysics primarily focused on biology’.

Thesis outline

In chapter 1, I formulate the question ‘what are we?’, clarify what the question means and what ‘we’ refers to, and explain what sort of answer might be expected. I argue that a good starting point for this investigation should be what science says about the nature of human beings. According to biology, human beings are animals. Therefore, animalism should be the default view of human identity. I present some arguments in favour of animalism, and tackle a few objections. However, animalist claims are varied. A quick survey of the animalist literature suggests three animalist claims, which are often used interchangeably, but should be distinguished: namely, that we are 1) animals; 2) human animals; or 3) organisms.

Chapter 2 assesses the first two options. I start by asking whether biological species such as *Homo sapiens*, or higher taxa such as the Animal Kingdom, can be considered natural kinds. After assessing various formulations of biological taxa as natural kinds, I conclude that we should either conceive of species and other biological taxa as historical individuals, or else as spatio-temporally restricted natural kinds defined by relational essences. In any case, these entities cannot tell us anything more substantial about what kind of thing we are, other than our location on the phylogenetic tree, i.e. how we are related to other organisms. Furthermore, individual organisms belong to their species and higher taxa only contingently. The contingency of species membership has previously been defended by Joseph LaPorte (1997, 2004) and Samir Okasha (2002). LaPorte (1997) also presented arguments for the contingency of higher taxa membership, but these arguments are flawed. He later argued for the necessity of higher taxa membership, while maintaining the contingency of species membership (2004). I argue that this position is untenable, since the contingency of species membership entails the contingency of higher taxa membership, and I present a novel argument for the latter. As a result, I conclude that we are not essentially members of the species *Homo sapiens*, and we are also not essentially animals, vertebrates, mammals, or members of any other taxa we belong to. None of the problems identified in chapter 2 extend to the concept ‘organism’, which is not a biological taxon, but a universal natural kind. Therefore, animalism can be maintained if formulated as the claim that we are organisms.

In chapter 3, I first assess what life is and whether it can be defined. I follow Ruiz-Mirazo et al. (2004) in highlighting the distinction between the historical-collective phenomenon of life and the life of an individual organism, and focus on the second as the concept which is relevant for understanding the nature of organisms. I defend a metabolic definition of life. I then turn to the problem of organismality, i.e., the question ‘What is an organism?’, which is distinct from various other questions broadly conceptualised as problems of ‘biological individuality’. I present a novel account of organisms as living material objects.[2] This account applies a naturalistic account of composition, according to which objects are bound states of matter (McKenzie & Muller 2017; Waechter & Ladyman 2019), to the particular case of living beings, and it overcomes many problems associated with other accounts of organismality, which often make problematic metaphysical assumptions. It also provides a useful framework for tackling difficult puzzles regarding organismality and organism individuality.

Chapter 4 discusses organismal persistence. I first argue that ‘organism’ is a persistence kind, because organisms persist over time in a distinct way from other material objects, and defend this view from the objection that organisms are functional kinds. I then discuss the persistence of organisms, starting with a relatively simple account that is suggested by the living objects view, and then investigate how cases of fission and fusion complicate this view. I investigate in detail the

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[2] Work developed in collaboration with James Ladyman.

question of whether cells survive symmetric and asymmetric cell division, cell fusion (focusing especially on the case of fertilisation in anisogamous species), and nuclear transfer in so-called ‘mitochondrial replacement techniques’. I also discuss cases of fission and fusion in multicellular organisms. I then present a general account of organismal persistence that is able to accommodate cases of fission and fusion.

In chapter 5, I tackle the question of when organisms begin and cease to exist. I assess various approaches to identifying the temporal boundaries of living objects within life cycles, and present several ways in which organisms can come into existence and cease to exist. I develop the notion of a ‘composite organism’, i.e., organisms that are partly composed of parts that are themselves alive, such as multicellular organisms, and I defend the view that organisms can be part of other organisms against several objections. I then focus on development as a case in which an object that is composed of living parts, but is not itself alive (namely, the early embryo), acquires the property life, over and above the lives of its component cells, when it acquires the capacity to engage in and coordinate metabolic activities and other life processes at the multicellular level of biological organisation. I argue that the life of sexually reproducing multicellular organisms does not begin at fertilisation, discussing several arguments for and against this view, and then attempt to determine when, during development, multicellular organisms begin to exist. I also examine the cases of multicellular aggregation and disaggregation.

Chapter 6 discusses death and suspended animation. I argue that death is the complete and irreversible cessation of the capacity to engage in and coordinate metabolic processes, and discuss how, in the case of composite organisms, since there is more than one life, there is also more than one death. I then argue in favour of the termination thesis, which is the claim that organisms cease to exist when they die: there are, strictly speaking, no dead organisms. I defend this view against several objections. The remainder of the chapter focuses on the phenomenon of cryptobiosis or suspended animation. Many organisms can survive in this state with their metabolism completely suspended. This may seem to constitute an objection to the view that organisms are a persistence kind in virtue of persisting in a different way from inert material objects. I argue that it is not possible for a dead organism to come back to life, and that cryptobiotic organisms are neither dead, nor in a different state which is neither dead nor alive; rather, they are alive, despite being temporarily ametabolic. The fact that it is possible for organisms to survive in a state of cryptobiosis in virtue of the preservation of their physical structure shows the importance of understanding organisms as living material objects.

CHAPTER 1

What Kind of Thing Are We?

The question 'What are we?' motivates this work. This chapter clarifies the question and provides a starting point for the inquiry. §1.1 introduces and clarifies the question, and identifies the kind of answer that would be appropriate, as well as the methodology that will be adopted. This thesis adopts a naturalistic approach to metaphysics, and in §1.2 I argue that, under this framework, animalism should be the default view of personal identity. In §1.3 and §1.4 I present evolutionary and other arguments for animalism, and discuss some objections. In §1.5 I discuss brain transplants, which arguably represent the main objection to animalism. After evaluating several animalist replies from the literature, I present my own solution. §1.6 assesses different answers to the question 'what are we' provided by animalists, and how they should be interpreted, and §1.7 is a brief conclusion.

1.1. The question

My goal in this thesis is to determine what kind of thing we are, and investigate what that tells us about our persistence conditions. In this section, I introduce the question 'what kind of thing are we?'. I take this question to be more or less equivalent to asking 'what are we?', with the advantage that it highlights what sort of answer is expected: the answer should refer to a *kind* of thing.

A first problem to consider is what is meant by 'we'. It is not easy to pin down the exact scope of 'we' in the question above. Eric Olson explicitly addresses this question in his book '*What Are We?'*. His approach is to restrict the question to "you and me and the people we know – we *human* people" (Olson 2007: 8), and exclude nonhuman persons.[3] This approach is intended to avoid assuming that all persons have the same metaphysical nature, in virtue of being persons – an assumption which would, for example, immediately exclude 'organisms' as a possible answer. At the very least, it seems that the 'we' in 'what kind of thing are we?' should include the reader and

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[3] Olson prefers to use 'people' rather than 'persons' as the plural of 'person' for stylistic reasons.

me. But I may not even be able to assume as much. If, in the future, an intelligent AI person reads this thesis, what I say here does not apply to that reader.[4]

In restricting 'we' to *human persons*, Olson (2007) does not mean simply "those people who are human beings" (10), since that itself is under dispute (e.g. Parfit 2016) – he means the persons who are either identical with (according to animalism), or have *the body* of a human being, or stand in some other kind of intimate relation to a particular human being (e.g. constitution). This way he avoids begging the question. In my view, however, restricting 'we' to human *persons* still assumes too much, as it seems to preclude the possibility that human *nonpersons* might belong to the same kind as we human persons. On the other hand, we should also not assume that all human beings are automatically included in virtue of being human. Furthermore, the notion of 'human being' is not perfectly clear either. Most commonly, it is used as a synonym for 'a member of the species *Homo sapiens*' (though see discussion in §1.6.2). Presumably this includes all adult and juvenile members of our species, but does it also include embryos and foetuses? It would be better not to assume a particular answer to this question from the outset.

The problem, then, is how to formulate the question 'what are we?' without begging the question. On the one hand, it should be possible to give the question a less ambiguous, and preferably non-indexical, formulation. But, on the other hand, an excessively precise restriction of the scope of 'we' might carry the assumption that things outside the extension thus defined are excluded from having the same metaphysical nature as those within. Therefore, I provisionally accept Olson's restriction of the scope of 'we' to 'human persons', adding the caveat that I do not thereby assume either that our fundamental nature derives from our being *human*, nor that it derives from our being *persons*; nor, indeed, that the kind that determines our metaphysical nature is restricted to human persons. Rather, the restriction in scope merely aims to pin down – to a very rough approximation – the things I want to enquire about.

We also need to consider what is meant by a kind of thing, and what would be an appropriate answer to the question 'what kind of thing are we?'. As I stated above, my main goal is to identify the kind of thing we are, and to determine the persistence conditions of things of that kind. An immediate problem with the project of trying to identify *the* kind of thing we are is that we appear to belong to many kinds: persons, animals, primates, mammals, living organisms, material objects, and more.

The personal identity debate has usually been framed as the search for the most adequate *substance concept* under which we fall (Wiggins 2001). Substance sortals are supposed to be

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[4] I owe this observation to James Ladyman.

concepts which not only apply present-tensedly to things at every moment of their existence (Wiggins 1967: 7; 2001: 30), but which could not cease to apply to the things they apply to unless those things ceased to exist. Personalists take *person* to be our substance concept, whereas animalists think that ‘person’ is not a substance concept at all; it is instead a *phase sortal*, as defined by David Wiggins (1967: 7; 2001: 30). Every particular object evidently falls under several concepts. Thus I am, simultaneously, a student, a philosopher, a placental mammal, a eukaryote, a sentient organism, a person, an adult, a human being, a female, and more. But I was not always an adult and, hopefully, will not always be a student. ‘Adult’ is a phase sortal, a concept to which individuals can belong temporarily (Blatti 2020), like larva, pupa, adolescent, etc., and can migrate into or out of without thereby ceasing to exist. ‘Student’ is a functional kind, which applies to things that have certain capacities or activities, but which also does not determine their persistence conditions. I ceased to be a child, and I can cease to be a student, without thereby ceasing to exist. On the other hand, it would be impossible for me to cease to be a eukaryote or a placental mammal while continuing to exist.[5] Yet neither has been proposed by animalist philosophers, as far as I know, as an appropriate substance sortal for things such as ourselves.

It seems that two assumptions are consistently made in the personal identity literature:

(i) there are natural kinds;

(ii) belonging to some natural kinds entails have certain persistence conditions.

Assumption (i) seems very reasonable. There are, after all, various things in the world.[6] Science studies these things and, and in so doing, scientists are often able to classify things into kinds that are independent of human interests. These are what is meant by natural kinds. Although a cat and a pencil are both part of the natural world insofar as both are material objects, it is reasonable to assume that the cat, being a natural object – as opposed to an artefact – falls under at least one natural kind (possibly more, and not necessarily a natural kind ‘*cat*’), whereas the pencil may not fall under any natural category more specific than ‘material object’, though it can be classified into artificial kinds for human purposes.

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[5] At least if a strong version of animalism is accepted.

[6] I will not attempt to specify what ‘thing’ means, which I take to be roughly synonymous with ‘entity’ and ‘object’. The claim that there are various things in the world is equally compatible with a traditional metaphysical view according to which at least some of these things are *substances*, as well as the view that ‘things’ are merely “locators for correlations holding across less than the whole universe that manage not to fall apart instantly” (Ladyman & Ross 2007: 243). This modest claim only excludes nihilist views.

The reason we may assume this is that cats are a legitimate subject of scientific research, whereas pencils are not: biology has something to say about cats (both as a species, and as individual organisms), whereas no science has anything to say about pencils.[7] While metaphysical accounts of natural kinds, or even the question of whether all natural kinds "can be defined in terms of the same general set of identity-criteria" (Tahko 2021), are more controversial, it seems relatively unproblematic to endorse the existence of different kinds of things in the natural world.

It is also reasonable to expect that science can tell us something about the properties of things that belong to those natural kinds it has identified. In the 17th century, the 'real essences of substances' were not only unknown, but "so far from our discovery and comprehension" (Locke 1689/1997: III.vi.9), that things could only be sorted according to their 'nominal essences', which were no more than complex ideas in our minds. Even then, Locke argued that our names for kinds or sorts of things should not merely represent our ideas, but "must agree with the truth of things" (III.xi.24). For this it is necessary that we "inquire into the nature and properties of the things themselves"; in order for our concepts to match the real kinds in nature, "*natural history is to be inquired into*; and their properties are, with care and examination, to be found out" (Locke 1689/1997: III.xi.24, emphasis in the original). While it may be disputed whether scientific inquiry discovers "the real essences of substances", we are certainly no longer in the dark as to the nature of most natural kinds; therefore, philosophy has no need to restrict itself to vague concepts with limited purchase on the world, and can directly refer to the natural kinds discovered by science.

With regards to assumption (ii), it seems very plausible that some kinds are temporary, such that things can belong to various temporary kinds, or 'phase sortals', throughout their existence. This seems an appropriate thing to say in the case of developmental stages of organisms, such as 'larva', 'pupa', 'tadpole', 'child', 'adult', etc.[8] Functional and ecological kinds can also be temporary; for example, an organism can be a parasite, or have locomotory capacity, during only part of its existence.

On the other hand, the assumption that some natural kinds somehow determine the persistence conditions of things which fall under them seems harder to justify. On a *sortalist* view, "some things go out of existence altogether; it's not just that they lose this property or that, but rather that they cease to exist. And the conditions under which they cease to exist are determined by

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[7] Qua pencils, that is – physics has plenty to say about the pencil's trajectory when falling, the properties of graphite, and so on.

[8] Although it is by no means uncontroversial whether these developmental stages are natural kinds, precisely because they are temporary stages. See Hennig (1966: 6) and Khalidi (1993: 108; 2013: 70-71) on why developmental stages such as *larva* should be considered natural kinds.

the kinds of things that they are" (Baker 2000: 37). But, except when the existence of a physical object comes to an end, what makes it the case that something has *ceased to exist* rather than just *becoming* something of a different kind? Some philosophers, most notably Peter Geach (1967), have argued that identity is relative, i.e. there is no fact of the matter as to when some *x* continues to exist (or ceases to exist) *tout court*, as opposed to continuing to exist (or ceasing to exist) *under a certain sortal concept*.[9] In contrast, E. J. Lowe (1989), Wiggins (1980, 2001), and other sortalists deny the relative identity thesis, but maintain that in order to know the identity and persistence conditions of some *x*, we need to know the *substance sortal* they belong to.

The claim that things have their identities in virtue of belonging to a particular kind or sort is not the same as the claim, also endorsed by Wiggins (2001: 7), that we can only 'pick out objects in thought' by picking them out under a sortal. This may or may not be true. Lowe (2007) agrees that we need to pick things out in thought, if not under a sortal, at least under some large 'category', whereas Michael Ayers (1974) and Paul Snowdon (2009) note that we are often perfectly able to pick out an object in thought without having any idea what it is – for example, we can think about an object we saw flying overhead yesterday and wonder whether it was a bird or a drone (Snowdon 2009: 265). Empirical evidence seems to show that people need to have no more than a *Spelke object* concept, i.e. "any entity that is three-dimensional, is bounded, and retains its boundedness as it moves through space and time" (Carey & Xu 1999: 327), in order to recognise something as an object, even when they are unable to classify it further; and even the need for any kind of sortal concept has been challenged (Rips & Leonard 2019). In any case, this is a question about human cognition, and will not be my focus here.

The relevant metaphysical question is whether some natural kinds entail specific persistence conditions. It is widely assumed that there is such a special set of natural kinds. These special natural kinds are variously called *basic kinds* (Schwartz 2009: 618), *fundamental kinds* (Roca-Royes 2011), *primary kinds* (Baker 2000: 40), *essential sortals* (Mackie 1994), *essential kinds* (Mackie 2006), *substance concepts* (Wiggins 1967: 7; 2001: 30, 69; Robinson 2016: 67), *ultimate sortals* (Wiggins 1967: 32; 2001: 67), and *persistence sortals* (Grandy & Freund 2023).[10] I prefer to frame the question in terms of *persistence kinds*, by which I mean a natural kind, the membership of which is associated with specific persistence conditions.

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[9] Geach (1967) reads Locke (1689/1997) as endorsing the relative identity view, but others have argued that this is an incorrect interpretation (see Chappell 1989).

[10] I'm not implying that these concepts are exactly equivalent. Also, some of these include artificial kinds; e.g. Baker's (2000) 'primary kinds' include statues, and Schwartz's (2009) 'basic kinds' include a subset of natural kinds but also artificial kinds such as televisions and refrigerators; I'll ignore those.

My definition of a persistence kind is not too far removed from Wiggins's (2001) notion of a substance-concept, which he specifies in the following way: "f is a substance-concept only if the grasp of f determines (with or without the help of further empirical information about the class of fs) what can and cannot befall any *x* in the extension of f, and what changes *x* tolerates without there ceasing to exist such a thing as *x*" (70). Where I differ from Wiggins is in the importance of concepts and our 'grasp' of them. For example, if it is a fact that organisms cease to exist when they die, it makes no difference whether or not there exists any mind capable of grasping that fact, or even the concept 'organism'. Likewise, Denis Robinson (2016: 67) defines a "substance-concept" as a "sortal or 'kind' concept so associated with *essential persistence-criteria* that something can begin or cease falling under it *only* by beginning or ceasing to exist". I too conceive of persistence kinds as having the property that something can begin or cease to fall under them only by beginning or ceasing to exist, but if there any such kinds, it is in virtue of the properties of things that belong to the kind in question, rather than in virtue of our concepts. The way I understand the notion of a persistence kind has little to do with our capacity to single things out in thought, or to grasp the meanings of concepts. For this reason I refer to persistence *kinds* rather than *concepts*.

I will not, however, assume that there are any persistence kinds. Though widely assumed by animalists and personalists alike, it would be preferable not to make this assumption. The fact that we speak of things coming to fall under certain concepts or ceasing to do so as occasions when something comes into existence or ceases to exist does not mean that *there are natural kinds in the world* such that things can only come to belong to them by coming into existence and can only cease to belong to them by ceasing to exist. What is needed is not evidence concerning how we apply our concepts or what *counts* as a member of this or that kind, but *empirical evidence* that members of specific natural kinds identified by science actually have specific persistence conditions. Though it may not seem that persistence conditions are the kind of thing for which one could obtain empirical evidence, in this thesis I argue that there is indeed empirical evidence that 'organism' is a natural kind whose members have specific persistence conditions, namely in virtue of their capacity to persist over time in a different way from other material objects. This makes 'organism' a persistence kind.

1.2. Animalism as the default view

In order to enquire into what we are and how we persist over time, this work straddles metaphysics and philosophy of science. I adopt a naturalistic approach to metaphysics, which aims to go “beyond mere consistency with current science” (Ladyman & Ross 2013: 109) but “looks to the results of contemporary science for guidance to the correct ontology” (Humphreys 2013: 51), and attempts to “draw out the metaphysical implications of contemporary science” (Kornblith 1994: 105). The science that is most relevant to this investigation is biology. In 1967, Wiggins remarked that “for the future of metaphysics no single part of philosophy of science was in more urgent need of development than the philosophy of biology” (xii).

There has been excellent work within philosophy of biology from naturalistic approaches embedded in biological science (e.g. Okasha 2006; Pradeu 2012; Dupré 2021). Often in this work the philosophy of biology is continuous with the metaphysics, and it may more properly be called ‘philosophy of nature’, as its aim is “to understand the universe”, rather than the activity of science (Godfrey-Smith 2014: 4); David Livingstone Smith (2017: 3) calls it ‘biophilosophy’. There have been few attempts, however, to integrate biology with physical science, in a way that acknowledges and explains the existence of biological objects. In fact, although proponents of naturalised metaphysics identify the unification of the sciences as an important goal (Ladyman & Ross 2006: 194; Ladyman 2012: 50), naturalised or scientific metaphysics has mainly focused on physics. For instance, Tim Maudlin states that the proper object of metaphysics “is the careful analysis of our best scientific theories (*and especially of fundamental physical theories*) with the goal of determining what they imply about the constitution of the physical world” (Maudlin 2007: 104, emphasis added). This almost exclusive focus on physics is unfortunate, considering that biology is uniquely placed to provide insight into our own nature. Furthermore, despite the obvious relevance of biology for these questions, there have been few attempts to integrate insights from biology and philosophy of biology with the metaphysical problem of personal identity (notable exceptions include Blatti 2012, Kingma 2019, Meincke 2019, and Olson 2021).[11]

In adopting a naturalistic approach to metaphysics, then, I believe the starting point should be what science has to say about what we are. Although scientists do not address the metaphysical question of personal identity, science does tell us unequivocally that, for all our impressive achievements, human beings are animals, that we are continuous with the rest of nature, and that our psychological capacities are continuous with those of other animals (e.g. Fabbro et al. 2015;

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[11] Snowdon (2014: 108-109) also gestured towards the possibility of naturalising the metaphysics of personal identity.

Tattersall 2022). Within the biological sciences, both ‘higher’ features such as cognitive capacities and more purely ‘biological’ features are often investigated in comparative studies featuring ‘humans and other animals’; the human exceptionalism taken for granted by many philosophers is largely absent from biology. The success of these biological explanations spanning physiology, ecology, behaviour, cognition, etc, is predicated on the evolutionary continuity between humans and other species. Therefore, the default view about our metaphysical nature should be that we are animals. The burden of proof should be on other views of personal identity, such as personalist views, which claim that we are *entities spatially coincident with animals but numerically different from them*.

Animalism is the metaphysical doctrine that we are animals. Most animalists (though not all) also accept the additional claim that we are essentially animals.[12] From a naturalistic or scientific perspective, animalism should be the default view on personal identity. Some animalist philosophers argue that animalism *is* indeed the default view. For example, Snowdon (2014) says that animalism “represents the default conception of ourselves” (106). Animalism is certainly “the view that many scientifically knowledgeable people assume and work within” and, in fact, consider “more or less obvious” (Blatti & Snowdon 2016: 11). However, it is because the view accords with what science tells us about ourselves that it is taken as more or less obvious by scientists; not because it accords with common sense. And it is generally thought that animalism “has biology on its side” (Noller 2022: 165); though it is true that animalism, as a metaphysical view of personal identity, does not straightforwardly *follow* from the facts of biology (Johnston 2016: 102). Still, its scientific adequacy should be taken as good prima facie evidence in its favour.

Olson (2007) argues that animalism is also the common-sense view of personal identity: “[m]ost ordinary people suppose that we are animals. At any rate, if you ask them what we are and indicate that ‘animals’ is one of the possible answers, they typically say that it is obviously the right answer” (23). While it is true that, compared with options such as “that we are bundles of perceptions, or immaterial substances, or nonanimals made of the same matter as animals”, animalism is a much more common sense approach (Olson 2007: 23), we should also bear in mind that many people think we are immaterial souls, and also that, in common discourse, most people use ‘animal’ precisely to mean ‘non-human animal’. What I would highlight instead is the *scientific adequacy* of animalism; whether or not it conforms to common sense is largely beside the point.

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[12] The stronger version of animalism which includes the claim that we are essentially animals is known as ‘strong animalism’ (Olson 2015a), ‘modal’ or ‘essentialist animalism’ (Sauchelli 2017), or ‘robust animalism’ (Duncan 2021, 2022); the non-essentialist version is known as ‘accidental animalism’ (Olson 2015b), ‘non-modal animalism’ (Sauchelli 2017); ‘animalism light’ (Duncan 2021, 2022), or ‘modest animalism’ (Francescotti 2022).

After all, the gradual evolution of new species from previously existing ones, population thinking (as opposed to typological thinking), and the fact that species have no intrinsic essences seem to be remarkably unpalatable to common sense, yet they are cornerstones of contemporary biology.

Nevertheless, Olson (2003) rightly points out that, if animalism tells us that things are as they appear to be (i.e., you are the animal you see in the mirror), whereas the alternative views tell us that things are very different from what they seem to be, that tends to shift the burden of proof onto the alternative views. Furthermore, animalism is a metaphysically more attractive theory than its rivals, insofar as it does not postulate additional entities – instead of two things, the person and the animal, with different properties, there is only one thing, the animal – nor does it require convoluted explanations of the relation that is supposed to hold between the person and the animal; according to animalism, this relation is simply numerical identity.[13]

1.3. Evolutionary arguments for animalism

The main *scientific* arguments for animalism come from facts about evolutionary biology. Human beings are a primate species with a specific location on the phylogenetic tree and a certain evolutionary history. For example, features of our anatomy, such as the fact that we have 5 fingers in each hand, or the shape of our hips, have good evolutionary explanations involving what traits were present in our ancestors, what evolutionary pressures they encountered, and how our lineage evolved in certain ways through natural selection. Thus, animalism enjoys an explanatory advantage over rival views of personal identity, in that “it can explain why the world contains us in terms of ordinary evolutionary theory”; furthermore, it can explain many features of human persons, such as “why we have special concerns about our own futures, and why we are drawn to sex, and eating, and so on, in terms of our nature as animals” (Blatti & Snowdon 2016: 11). More generally, on the animalist view, the fact that our personal interests and what is good and bad for us so closely align with the interests of, and with what is good or bad for, the animals we ‘are’ is entirely expected if we literally are those animals, i.e., if the relationship between human person and human animal is

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[13] Snowdon (2014: 79-81) argues that it is not clear that Ockham’s razor should be applied in metaphysics, and therefore this argument fails to establish the claim that animalism is the default view. I agree that its application in metaphysics is not straightforward but, unlike Snowdon, I believe it does provide prima facie reason to consider animalism to be the default view – especially as the alternatives postulate both additional entities and additional metaphysical complexity.

one of identity, whereas on any other view of personal identity, such intimate associations are highly surprising (Bailey 2017).

1.3.1. Animal ancestors

A more explicit evolutionary argument in favour of animalism is Stephan Blatti's (2012) *Animal Ancestors Argument*:

> "Assume for *reductio* that animalism is false. If you are not an animal, then nor are your parents animals. But then, nor are your parents' parents, nor your parents' grandparents and so on, as far back as your ancestry extends. In this case, the falsity of animalism entails the rejection of evolutionary theory (or at least that theory's applicability to us), since it means denying that your distant ancestry includes beings who were animals. But, since the rejection of evolutionary theory is too high a price to pay, we should reject the assumption that animalism is false."
> (Blatti 2012: 686)

Though hardly anyone could be more in favour of marshalling evolutionary theory in support of animalism than myself, the argument does not strike me as a very solid one. Compare with David Sanford's (1975) 'proof' that there aren't any mammals (quoted in Dennett 2017: 13):

> "1. Every mammal has a mammal for a mother.
>
> 2. If there have been any mammals at all, there have been only a finite number of mammals.
>
> 3. But if there has been even one mammal, then by (1), there have been an infinity of mammals, which contradicts (2), so there can't have been any mammals." (Sanford 1975).

As Dennett (2017) explains, we cannot get out of this pickle by postulating a 'Prime Mammal' that didn't have a mammal for a mother. What we should say instead is that some ancestors of mammals were somewhat mammal-like, some closer ancestors of mammals were even more mammal-like, and at some point their descendants were definitely mammals. We can say that there was a first mammal *species,* which is the stem species of the clade Mammalia and is thereby included in the mammals. But we could not – even in principle; even if we were in possession of all the relevant fossils – point to an exact organism that was the first mammal. Evolution is gradual; even speciation can take millions of years.

The example nicely illustrates the problem of trying to extend anything that is true of some organisms existing now into their past evolutionary history: precisely because of the nature of evolution, most of the things that are true of any extant organisms were not true of many of their ancestors far back in time, and vice versa. Consider another example: I lack the capacity to reproduce asexually (true). If I lack this capacity, then my parents also lack this capacity (also true). But then, this was also true of their parents (true), *and so on, as far back as my ancestry extends*. But of course that is where the argument goes wrong: if you go back in time far enough, some of my ancestors *did* reproduce asexually. We can repeat the exercise for any feature that changed in the course of evolution.

Thus, it is not immediately evident that Blatti's argument works, because the relation between a biological feature being true of us now and it also being true of our parents is not transitive all the way back across our entire evolutionary history. For almost any feature, if we go back far enough in time we're bound to find some distant ancestor where it was not present. However, being an animal, like being a mammal, is not simply an evolved feature of an organism: it refers to a clade the organism belongs to; a 'branch' of the phylogenetic tree. And clades have the following interesting property: according to phylogenetics, all the descendants of a member of a given clade will always belong to that clade (Okasha 2003). So, for instance, although it is false that if an organism is a mammal then all its ancestors were mammals, it is true that, if an organism is a mammal, and Mammalia is a clade, then all its descendants, no matter how far away in time, will always belong to the clade Mammalia. They may lose or acquire many biological properties, but they cannot cease to be mammals.[14]

So it is relatively easy to salvage Blatti's argument: evolutionary theory says that some of our ancestors were animals. If some of our ancestors were animals, then according to phylogenetics, all their descendants are also animals. Therefore, we are animals. Formally, here is the revised animal ancestors argument – the *Animal Descendants Argument*:

P1. Some of our ancestors were animals. [from evolutionary theory]

P2. All the descendants of animals are animals. [from phylogenetic theory]

C. We are animals.

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[14] See Appendix 1 for more detail on phylogenetics.

Blatti (2012) makes additional claims that can be disputed: for example, he says that “evolution is not a process that begins with one kind of thing and results in another kind of thing”, and that evolution “may operate so as to produce new varieties of organisms, but it does not operate so as to produce *non*-organisms” (686). Concerning the latter, Carl Gillett (2013) rightly counters that lots of things that are not organisms are also the products of evolution, for instance organs and cellular structures such as ribosomes. But as Chris Daly and David Liggins (2013) point out, Blatti does not need this premise at all. As to evolution not being able to produce new kinds of things, that depends on what one accepts as natural kinds. If biological species are natural kinds, then evolution arguably does exactly that.[15] [16] But even if species are not natural kinds, it does not follow that evolution cannot produce new kinds of things. It can certainly produce things that did not exist before, for example: multicellular organisms, trees, hearts, flying organisms, sentient organisms, etc. In fact, we might add ‘persons’ to that list. As Blatti (2012: 687) notes, the animalist can concede “that most human animals are persons, that human animals are the descendants of persons, and that there was a time before which our distant ancestors were not persons”, as long as *person* “is not construed as a substance concept”. But in any case, this premise is also not part of Blatti’s argument, and it plays no part in my suggested revision of it.

The main objection raised by Daly and Liggins is quite different: they think “we should not dismiss a philosophical theory just because it is inconsistent with one of our best theories from another discipline” (Daly & Liggins 2013: 608) and, in the case at hand, they believe that “the metaphysics of persons needs to avoid uncritical deference to current best biology” (609). There seems to be a profound methodological impasse here: where scientific metaphysics aims precisely at integrating philosophy with our best current science, some philosophers reject such an integration. This is surprising, because many analytic metaphysicians who do not actively embrace a naturalistic approach to metaphysics nevertheless consistently acknowledge the scientific expertise of biologists on matters related to life, organisms, and animals, as an important source of evidence for metaphysical thinking on personal identity, and often appeal to scientific evidence. For instance, Peter van Inwagen quotes at length a biologist and a neurophysiologist in his discussion of life (van Inwagen 1990: 92-93); Olson quotes several biologists in his exposition of the biological approach to human identity (Olson 1997a: 124-135); and philosophers discussing brain transplants frequently appeal to facts of biology, neuroanatomy, and physiology. In fact, it is puzzling how one

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[15] In chapter 2 I argue that biological species are *not* natural kinds.

[16] Although some (e.g., Platonists) would say that natural kinds are abstract objects which exist all along, and evolution only causes the kind to become instantiated. I am grateful to Samir Okasha for pointing this out.

could discuss whether human persons are animals without *any* input from the science that studies living things.

Although science is certainly fallible, it is the best method we have of finding out about things in the world, and philosophy should not isolate itself from it. Certainly, “we should reject standard evolutionary theory if we can find a better theory” (Daly & Liggins 2013: 607). But we – or, rather, biologists – have not. Therefore, we should accept it, unless and until such time as a better theory is found. Daly and Liggins (2013) suggest that “[p]erhaps, if intellectual and scientific history had gone slightly differently, standard evolutionary theory would have presupposed Lockeanism, not animalism” (608). But actually, we could say that ‘animalist’ and ‘Lockean’ versions of evolution were indeed proposed – simultaneously, as it happened. While Darwin (1871) saw human cognitive capacities as no less a product of evolution than any other feature, Wallace thought that natural selection applied to *everything but the human mind*: “[t]hese faculties could not possibly have been developed by means of the same laws which have determined the progressive development of the organic world in general, and also of man's physical organism” (Wallace 1889/2009: 475). The fact that Darwin’s theory of evolution prevailed over Wallace’s cannot be simply attributed to the accident of intellectual and scientific history, but to its far greater explanatory power.

1.3.2. Mental capacities and evolutionary continuity of mental experience

At least two other evolutionary arguments may be given in support of animalism. One is suggested by Snowdon (2014: 108-109), who claims to have been influenced by Blatti (2012). I will call it the *Argument from the Evolution of Mental Capacities*. We have certain cognitive capacities, and evolutionary biology tells us that those capacities were acquired by our ancestors over the evolutionary history of the human lineage. As Snowdon (2014) points out, these capacities are capacities of certain animals, and they perform certain roles *for those animals* – or, in less teleological language, those capacities evolved because they conferred higher fitness on the animals that possessed them. They are capacities *of* those animals.[17] Snowdon then makes the additional assumption that these capacities cannot cease to be capacities of those animals and be reassigned as mechanisms of some other entity. This is a very reasonable assumption – animals may have or lack certain capacities, but the capacities themselves are not free-floating entities that can suddenly shift

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[17] I have replaced ‘for’ with ‘of’, to avoid unnecessary teleological implications.

to being capacities of something else. Thus, Snowdon (2014) concludes that, if “my self-conscious capacity is a capacity [of] this animal, and so is my memory mechanism”, then, “my understanding of my own capacities, as a self-conscious and memory possessing thing, implies that I am that animal, for my only understanding of their existence and presence rests on their role for an animal” (109).

A third evolutionary argument I want to suggest is the *Argument from Evolutionary Continuity of Mental Experience*. Suppose that human beings have psychological persistence conditions, i.e. they persist in virtue of psychological continuity, rather than in virtue of biological continuity. Many nonhuman animals also think, feel, and generally have mental experiences. Either those nonhuman animals also have psychological persistence conditions, or they do not. If they do not, then there is a radical discontinuity between the persistence conditions of humans and all other animals. If they do, then there is a radical discontinuity between the persistence conditions of humans and some nonhuman animals vs. all other organisms. Either way, due to the gradual nature of evolution, it is implausible that this discontinuity can be explained within an evolutionary framework.

Empirical evidence supports the evolutionary continuity of mental experience. Studies of comparative neurophysiology have uncovered “no fundamental differences between the structure or function of neurons and synapses in men and other animals”, making it more parsimonious to conclude that mental experiences in different species “are as similar (...) as are the neurophysiological processes” on which they are based, which in turn, implies “qualitative evolutionary continuity (though not identity) of mental experiences” among many nonhuman animals (Griffin 1976: 104). Neuroanatomic, neurophysiological, and neuropsychological data support the view that some aspects of self and world representation are present in all vertebrates, and that self-consciousness is likely present in at least some mammals and birds (Fabbro et al. 2015). The denial of this evolutionary continuity is therefore unappealing.

The second horn is taken by several personalists who argue that some nonhuman animals also have psychological persistence conditions. For instance, Peter Unger (2000) argues that sentient animals like cats and dogs have psychological persistence conditions, unlike non-sentient living beings, such as trees and skin cells. Sydney Shoemaker (2016: 128-129) is happy to accept this; for example, he argues that a dog would survive a cerebrum transplant as the transplanted cerebrum. He thinks this does not entail the denial that dogs are animals, but it does entail the denial that they have purely biological persistence conditions, which many will find equally surprising. Mark Johnston (2016: 126) is also happy to attribute psychological persistence conditions to some nonhuman animals, though he is unsure which ones qualify – dogs and dolphins are “good candidates to be persons"; frogs not so much; sponges are definitely out, since they have "no mental life at all" (nor do they have brains). Christopher Hughes (2018) also suggests that perhaps some "unthinking" animals do have "the persistence conditions animalists attribute to organisms", but "thinking animals", such as mammals, have different ones (238-239).[18]

At present, most of these arguments seem little more than an afterthought to traditional personalist views; their aim is to render psychological continuity theories immune to objections from the evolutionary continuity of mental experience. However, it may be possible to develop a *sentientist* view, which combines animalism with a minimal psychological continuity requirement in the form of sentience. Although both sentience and personhood are important evolutionary breakthroughs, it is unlikely that either could justify a sudden radical change in the persistence conditions of organisms that instantiate these properties. Unlike full-on personhood, minimal sentience is (at least in vertebrates) closely associated with areas of the brain that are responsible for the coordination of animal life, namely certain brainstem nuclei (Parvizi & Damasio 2001; Damasio 2010). This suggests the possibility that sentience may be *both* a psychological property and a biological property that is essential for the persistence of some complex animals. The resulting view, *sentience animalism*, may be able to reconcile the intuition that personal identity involves some kind of psychological continuity with the animalist view that our persistence conditions must be biological (see §1.5 for additional discussion).

1.4. Other arguments for animalism

In most discussions of animalism, the main argument advanced in its favour is the *Thinking Animal Argument* (also known as '*Too Many Thinkers*'). It goes like this:

> "(1) There is a human animal sitting in your chair. (2) The human animal sitting in your chair is thinking. (If you like, every human animal sitting there is thinking.) (3) You are the thinking being sitting in your chair. The one and only thinking being sitting in your chair is none other than you. Hence, you are that animal. That animal is you. And there is nothing special about you: we are all animals." (Olson 2003: 325)

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[18] See also Mark Rowlands's (2019) intriguing defence of the view that (nonhuman) animals can be persons.

Here is Blatti's formulation:

> "P1. Presently sitting in your chair is a human animal.
>
> P2. The human animal sitting in your chair is thinking.
>
> P3. You are the thinking being sitting in your chair.
>
> C. Therefore, the human animal sitting in your chair is you." (Blatti 2020)

The argument is beautiful in its simplicity, and all premises are extremely reasonable. P1 is pretty much impossible to reject except on wildly improbable metaphysical views. P2 is in fact rejected by some personalists who deny outright that animals can think, because they have the wrong persistence conditions (Shoemaker 1999a).

Shoemaker's argument is that mental states typically produce their effects – further mental states or behaviour – in the same person whose mental states they are, and in association with other mental states of the same person. Therefore, he concludes that persons – in fact, any subject of mental states – must have psychological persistence conditions (Shoemaker 1999a; 2004). Human animals do not have the required psychological persistence conditions; therefore they cannot think. But as Olson (2007) notes, it just "doesn't seem absolutely necessary that the characteristic effects of a being's mental states must always occur in that very being" (34); for example, they would not do so in hypothetical fission cases. Mental states also typically produce their effects in conjunction with other *physical* states of the same person; yet Shoemaker seems prepared to accept that this is not necessary. Furthermore, Shoemaker's argument seems to assume the existence of psychological continuers; but to assume that is already to accept a psychological continuity account of persistence (Olson 2002).

P3 could also be rejected, but its rejection carries the consequence that there is more than one thinking thing currently sitting in your chair. Some personalists are prepared to accept this consequence and work around it by invoking either a difference in thinking first-person thoughts derivatively and non-derivatively (Baker 2000), or an ambiguity in the reference of 'I' (Noonan 2001). Lynne Rudder Baker (2000), who argues that persons are constituted by human organisms, claims that the person has a first-person perspective essentially and non-derivatively, whereas the human organism that constitutes her has a first-person perspective contingently and derivatively (and vice-versa for 'animal' properties, like being overweight) (2000: 59, 91-101). Her view, however (and constitution views more generally), implies that there are two co-located entities composed of the same matter arranged in the same way, which nonetheless have different properties.[19]

These objections do not seem very compelling. There is however one potentially more problematic objection to the thinking animal argument – the *Thinking Parts Problem*. Blatti (2020) presents it in the following way: "even if you are a thinking being, no reason has been given to suppose that you are a thinking *animal* rather than any of the other thinking beings currently located where you are". The objection rejects P3, denying that there is only one thinking being currently located where you are, because many parts of the animal are also plausibly thinking beings – for example, "the head, the brain, the right-leg complement (i.e., the entire animal body minus the right leg), the entire animal from the waist up (torso, neck, and head)", etc. Evidently, this is only a problem if these various things exist. Olson (2007) thinks that animalists should solve the thinking parts problem "by denying the existence of the entities that would generate them" (221). His preferred solution is to adopt van Inwagen's (1990) moderately eliminativist ontology, which Olson calls 'biological minimalism' (2007: 226). On that view, the only composite objects that exist are living organisms, which rules out all those alternative candidate thinking beings. This way, animalists can resist the thinking parts problem easily: there are no thinking beings other than the organism.

However, van Inwagen's is a very radical ontology that also eliminates things like rocks and tables. Olson (2007) is sceptical that other moderate theories of composition will do: "why suppose that any good theory of composition will be consistent with both the existence of human animals and the nonexistence of undetached heads, clay statues, and the rest of the troublesome lot?" (225). But there is at least one moderate view of composition that fares well in this regard. The bound state view says that things compose something iff they are in a bound state (McKenzie & Muller 2017; Waechter & Ladyman 2019).[20] On this view of composition, only one of the things mentioned by Blatti (2020) is plausibly a composite object: the brain. Heads, upper halves, right-leg complements, and the like are ruled out by the view, since they are not composite objects by themselves, but only form composite objects together with other parts of the organism.[21] But some structures within the organism are composite objects on the bound state view: cells, bones, and possibly organs

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[19] See Olson (1996) for discussion of why this is exceedingly implausible.

[20] The bound state view is discussed in more detail in §3.2.2.

[21] As are hands. The bound state view is compatible with Olson's (1995a) claim that, strictly speaking, I have no hands. The cells in my hands are, however, perfectly good composite objects on this view, as are the bones, and many other structures.

such as the liver, kidney, and even the brain (or at any rate the central nervous system, which includes the spinal cord) are separated to some degree from the surrounding tissue by a physical boundary, and arguably form a bound state.[22] In the case of cells this boundary is the cell membrane; in the case of the brain, the meninges.

That is a very good result – the bound state view of composition can get rid of all sorts of gerrymandered objects that would be potential candidates for thinking, while at the same time maintaining the existence of rocks, tables, and countless other objects recognised by science as well as common sense. However, there is one composite object – the brain – that is not ruled out by the view, which means that the thinking parts problem is not entirely solved by adopting the bound state view of composition.

One possible reason for thinking that we are the brain rather than the organism is the argument that only the brain thinks in the strictest sense. Olson (2007: 79) summarises the argument as follows:

(1) There is such a thing as my brain.
(2) My brain thinks my thoughts in the strictest sense.
(3) If my brain thinks my thoughts in the strictest sense, then anything else that thinks my thoughts does so only in the derivative sense of having a part that thinks in the strictest sense.
(4) If anything thinks my thoughts in the strictest sense, I do.
(C) Therefore, I am my brain. (Olson 2007: 79).

The main reason for supposing that it is the brain that thinks in the strictest sense is *thinking-subject minimalism*, i.e., the view that something can only be a part of a thinker if it is directly involved in thought (Olson 2007: 88). But it is not easy to make this view coherent. Is the whole brain involved in thinking? Presumably not all at once. Is the thinker of a thought composed of only those neurons directly involved in that thought? Do glial cells count as part of the thinker if they do not participate in thought? Olson (2007) compares the idea that all parts of a thinker must be directly involved in thinking with the view that all parts of a walker must be directly involved in walking; in both cases, there is no principled way to determine

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[22] This is not the case for organs that are individuated purely on functional grounds, such as the stomach and the small intestine.

which parts are ‘directly involved’ in the activity. Thus is it highly implausible to maintain the view that only brains think in the strictest sense.[23]

However, as Olson (2007) points out, “[e]ven if brains are not the only true thinkers, it doesn’t follow that they don’t think at all” (215). And if they do, animalism still faces a thinking parts problem. On certain views of composition, such as van Inwagen’s (1990), there are, strictly speaking, no brains, so the problem disappears; Olson thinks that adopting some sparse ontology view may be the animalist’s best option in the face of the thinking parts problem (2007: 221-222).[24] How might someone who adopts the bound state view of composition rather than van Inwagen’s biological minimalism respond to this problem?

I think that we should carefully examine the claim that we are ‘a thinking thing’. The appeal of the idea that we are our brains rather than the organism of which the brain is a part lies in the fact that the brain is ‘the organ of thought’: “If we are brains, it can only be because the brain is our organ of thought” (Olson 2007: 87). But what makes it appealing that we could be our organ of thought? I suggest that the only thing that makes it appealing is the assumption that we are (essentially) thinking things. The idea is that (1) I am a thinking thing (i.e., a thing that thinks); (2) my brain thinks; (3) therefore, I could be the brain (I could also be the organism, because the organism also thinks, but it’s bad enough if I can’t know which one I am).

Now let us compare this with a very similar argument: (1) I am a digesting thing (i.e., a thing that digests); (2) my stomach digests; (3) therefore, I could be my stomach. Why is this argument less appealing than the previous one? Why is it not at all appealing? One reason might be because we think that digestion is an activity or capacity that is not essential to us. Presumably, I could continue to exist without the capacity to digest (for example, if I were fed pre-digested nutrients, which I would only need to absorb). So one reason that the thinking brain argument is appealing is because we think that thinking is essential to us; that we are essentially thinking things. But we have no good reason to make this assumption.

Consider Descartes’ (1641/1996) *Cogito*: from the fact that I am thinking (which I can observe through introspection), it follows that I exist. What does not follow is the further claim that, therefore, I am *essentially* a thinking thing. From the fact that I am thinking, it

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[23] Even assuming that other parts of the body do not participate in thinking, an assumption which can also be challenged – for example, the possibility that the 200-600 million nerve cells surrounding the digestive system also participate in thinking cannot be ruled out (see Mayer 2011).

[24] Another solution would be to argue that brains do not think at all, or do not think in the same way we do. Olson (2007: 81-84) reviews a few arguments for that claim, but considers them unpersuasive.

follows that I exist and that right now I have the capacity to think. But it does not follow that I am essentially a thinking thing, nor that I cease to exist if I lose this capacity. Compare: from the fact that I am walking right now it follows that I am something that right now has the capacity to walk; but it does not follow that I am essentially a walking thing, nor that I would cease to exist if I were to lose this capacity. We need additional evidence concerning what we are and what changes we can survive; we cannot derive them from the fact that we are something which (at least right now) has the capacity to think.

The point of the inquiry into the metaphysics of personal identity is precisely to answer the question ‘What are we?’. To assume from the outset an answer to this question in the form of ‘We are thinking things’ is question-begging. Of course, we may correctly assume that we are something that is currently thinking; but that does not make us essentially thinking things. But if we do not assume that we are essentially, primarily, or exclusively thinking things, then we have no reason whatsoever to think that we are our brains. All evidence points to us being the organism rather than the brain. The fact that I can move, feel, and see various parts of my body strongly suggests that these are parts of me. Experience demonstrates that I can digest food; therefore I have reason to believe that this a capacity I also have, no less than thinking.

Consider the following possible paraphrase of the thinking animal argument, this time featuring the *Shivering Animal Argument*:

P1. Presently sitting in your chair is a human animal.

P2. The human animal sitting in your chair is shivering.

P3. You are the shivering being sitting in your chair.

C. Therefore, the human animal sitting in your chair is you.

Is this argument any less compelling than the thinking animal argument? Not really. How do I know that I am shivering? Well, I can both feel it and observe it. If anything, I have *more* evidence for it than for the fact that I am thinking, which I know from introspection alone. And the same will be true of all sorts of bodily functions which we both introspect (through feelings, sensations, and proprioception) and perceive through our senses – not to mention that many of these can be confirmed by external observers. If we do not assume from the outset that we are essentially thinking things, there should be no special role for ‘thinking’ in the thinking animal argument. Since ‘thinking’ can be replaced with any other activity that the human animal sitting in my chair is currently doing – including involuntary activities – there is no good reason to think that I am the brain or any other organ of that human animal; it is much more likely that I am the animal.

Evidently, this is not a knock-down argument against the view that we are our brains. But it shows that even accepting that (i) there are brains, and (ii) brains can think, the view that we are our brains is not very appealing, and there is abundant evidence against it. I will now consider the main objection to animalism.

1.5. Animalism and brain transplants

Despite the prima facie plausibility of animalism, alternative views of personal identity have always been more popular in philosophy (though animalism has become somewhat more prominent in recent years).[25] While dualist theories of minds or souls are rarely defended nowadays, other personalist or neo-Lockean theories enjoy wide support. Among these the most important is the view that we are persons constituted by animals, but not identical with them. Adherence to these views stems mainly from the intuition that psychology is a very important feature of human persons, and that our persistence conditions should therefore have something to do with psychology, which animalism typically denies. These intuitions are most forcefully brought out by thought experiments that appeal to the 'brain intuition' or 'transplant intuition' (Lim 2019, 2023; Skrzypek & Mangino 2021), i.e. the intuition that if your brain were extracted from your body, you would go with the brain.

Shoemaker (1963: 22) introduced brain transplant thought experiments as an argument against 'bodily criteria' of personal identity, and they can be seen as a modern, materialist take on Locke's thought experiment where a prince and a cobbler exchange souls. Shoemaker asks us to suppose that the extraction of the brain from the skull of a patient and its later re-attachment is a safe and routine procedure. One day, in the course of surgical procedures on the brains of two men, Brown and Robinson, their brains are inadvertently swapped. One of them dies, but the other, consisting of Robinson's body and Brown's brain ('Brownson') survives and regains consciousness. He thinks of himself as Brown, recognises Brown's wife and family, and describes in detail events in Brown's life as events in his own life. Shoemaker's conclusion is that, in such a situation, we

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[25] For recent defences of animalism, see Bailey and Pruss (2021), Francescotti (2022), Lim (2023), Meincke (2021), Olson and Witt (2020), Thornton and Bailey (2021), Yang (2020).

would be strongly inclined to say that, despite having Robinson’s body, Brownson is actually Brown. This seems to show that we have a psychological criterion of identity that overrides any ‘physical’ criteria.

The animalist, however, need not deny that Brown survives the operation as Brownson. Rather than accepting a psychological criterion of persistence, the animalist can say that the animal goes with the brain because the brain coordinates the life processes of the organism. This is van Inwagen’s view (1990: 172-181), which Olson endorses as well (1997a: 45). The reason that Brown survives the brain transplant is not because Brownson is psychologically continuous with Brown; it is because the two are biologically continuous. On a coordination of life processes criterion of persistence (Liao 2006), the central nervous system, in particular the brain, is an essential part of the organism because it coordinates the vital processes of the organism. Certain areas in the brainstem regulate respiratory function, heart rate, blood pressure, and the sleep-wake cycle; the hypothalamus regulates endocrine function and body temperature; etc. Since these essential areas for coordination of life processes are located in the brain, the organism that ends up with these coordinating areas is the original animal; hence, Brown survives the transplant.

Most philosophers also think that, if the cerebrum, rather than the whole brain, was transplanted, the result would be a human being psychologically continuous with the person whose cerebrum it originally was (Olson 1997a: 9-10). This is an important objection to animalism. Animalism says that, if we underwent such a procedure, we would survive as the decerebrated human being left behind, rather than as the human being who gets our cerebrum; whereas it seems evident that we should be prudentially concerned with the latter, and not the former. Some animalists seem prepared to accept something along the lines of Parfit’s (1984) ‘identity is not what matters’, i.e., to separate the metaphysical question of identity from the normative question of where prudential concern is appropriate (Olson 1997a: 52-57, 70).

Others have argued that animalists should accept the brain intuition or transplant intuition but deny that it falsifies animalism. For example, Rory Madden (2016) argues that the human animal can persist as an extracted cerebrum, because it preserves “a sufficient number of capacities for human-animal-characteristic activity” (7). But this is highly implausible, since the cerebrum on its own lacks the capacity for life regulation (for criticism of this view, see Skrzypek & Mangino 2021). Another attempt to reconcile animalism with the transplant intuition involves arguing that animalism is compatible with *both* psychological and biological persistence conditions – Andrew Bailey (2015) calls this *disjunctive animalism*. This can be achieved at the cost of dropping the essentialist claim (that we are essentially animals). However, Harold Noonan (2021) argues that this *hybrid view* is neither animalism nor personalism, but something in between.

Another recent animalist reply is to accept the transplant intuition, but maintain that the central animalist claim that “we are animals” is a generic claim that admits of exceptions, in the way that “tigers have stripes” is a generic claim that is not falsified by the existence of occasional stripeless tigers (Bailey & van Elswyk 2021). This reply commits the animalist to only modest or weak animalism. But this is not the main problem with it.

There are two possible ways of understanding the scope of the generic claim. One is to take it as referring to all persons who are members of the species *Homo sapiens*; i.e., organisms that belong to that species, or, in other words, human beings. Another would be to understand it as referring to all persons who have the property ‘being human’. Many things have the property ‘being human’ even though they are not human beings, for example “organs, cells, and other body parts” (Francescotti 2022: 18), and even things like DNA sequences and language.[26]

Understood in the first sense, the generic claim is false: ‘members of the species *Homo sapiens* are animals’ does not admit of exceptions. If it were possible for a human animal to survive a cerebrum transplant and thereby become a non-animal, it would also no longer be a member of our species. It would certainly remain human, but only in the second sense. Thus, the comparison between the generic animalist claim that ‘all human persons are animals’ and claims such as “birds lay eggs”, “sea turtles are long-lived”, “lions have manes”, and “ravens are black” (Bailey & van Elswyk 2021) is misleading. The fact that, for example, raven’s hearts are not black or that the stomach cells of sea turtles are not long-lived are neither here nor there with regards to the truth of those generic claims, because they refer to *members of a biological taxon*, i.e. they refer to the organisms that belong to these taxa, not to their body parts. Therefore, it is not plausible to hold that “we are animals” is a generic claim about human beings in the same way that “tigers have stripes” is a generic claim about tigers.

But even though they make various parallels with generic claims about members of biological species and other taxa, Bailey and van Elswyk (2021) formulate their generic animalist claim in terms of ‘human persons’, and they explicitly refer to “the kind human person” (415). But what sort of kind is ‘human person’? If it is a kind at all, then it is either a kind that corresponds to the intersection of ‘person’ with the biological taxon ‘*Homo sapiens*’, in which case it includes all and only those beings that belong simultaneously to both; or else ‘human’ is intended in the second sense, as a property that can apply not only to organisms, but also to many other things.

If it is a combination of the kind ‘person’ with the biological taxon *Homo sapiens*, then it should behave like other such combinations, such as ‘mammalian predator’, understood in the same

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[26] See also discussion in §6.2.2.

way. Just as there can be no exceptions to the claim that ‘all mammalian predators are mammals’, there can also be no exceptions to the claim that ‘all human persons are human beings’, and since human beings are animals, there can be no exceptions to the claim that ‘all human persons are animals’, contradicting generic animalism.

If, on the other hand, ‘human’ in the generic animalist claim is understood in the second sense, then there might be exceptions to the generic claim. But the sense in which there can be exceptions is a highly forced one. Consider again the case of ‘mammalian predator’, but now interpreting ‘mammalian’ as a property that can apply, not only to organisms that belong to the class Mammalia, but also to their body parts, genes, and so on. Let ‘predator’ be defined as a living thing that eats other living things. Now suppose that someone argues that there are exceptions to the claim that ‘all mammalian predators are multicellular’, on the grounds that some white blood cells of lions actively ingest bacteria. Technically, this would indeed be an exception to the claim, since the white blood cells are mammalian because the lion is a mammal, and these cells do exhibit predatory behaviour. But the sense in which it constitutes an exception to the claim is not the sense in which generalisations about members of a species admit of exceptions. If this is how we should understand ‘human persons’, then the fact that “[l]ike other biological classifications, the species *[H]omo sapiens* is not fixed by universal generalization; it admits of exceptions and outliers” (Bailey & van Elswyk 2021: 426) has nothing to do with the reason why ‘human persons are animals’ allegedly admits of exceptions, and it is misleading to appeal to features of biological classification to defend generic animalism.

I suggest another reply entirely: the animalist should reject the transplant intuition because it is based on a flawed understanding of neuroscience, and in particular how the self is produced by the brain. According to neuroscientists Antonio Damasio and Jaak Panksepp, among others, the self is built in layers, including a form of minimal subjectivity, called the proto-self, which generates primordial feelings that form the basis of emotions and a felt map of the organism; the core self, which involves a sense of agency and ownership of one’s experiences; and the autobiographical or narrative self, which requires language and is likely restricted to humans (Panksepp 1998; Damasio 2010; Fabbro et al. 2015).[27] Assuming a Lockean conception of ‘person’ as “a thinking intelligent being, that has reason and reflection, and can consider itself as itself, the same thinking thing in different times and places” (Locke 1689/1997: II.xxvii.9), the autobiographical self is arguably what is required for personhood.[28] However, while the bottom layers of self can be instantiated in the

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[27] Panksepp and others identify an additional layer before the last, *self-consciousness*, which is typically attributed to animals who can recognise themselves in a mirror (Fabbro et al. 2015).

[28] The concept of the *autobiographical self* is not too remote from Locke’s notion of *personal self*: “as far as any

absence of the top layers, the converse is not true; there can be no autobiographical self without proto-self and core self. Since the proto-self is primarily instantiated in the brainstem, it follows that there is no person in an extracted cerebrum. This eliminates the remnant-person problem, i.e., the problem of where the person in the extracted cerebrum comes from (Johnston 2007, 2016; Olson 2016; Lim 2023), because no such thing exists.

However, it does not immediately solve the cerebrum transplant problem, because it is conceivable that, once appropriately connected with a functioning brainstem and provided with signals coming from its new body, the cerebrum might once again instantiate the autobiographical self and, therefore, a person. Since most of the memories and other important biographical information are stored in the cerebrum, psychological continuity theorists would say that there is sufficient psychological continuity to conclude that a person can survive a cerebrum transplant. There are two things that the animalist can say in reply. One is that, even on the psychological continuity theorist's terms, although it is plausible that the cerebrum could work once connected with a functioning brainstem and provided with bodily signals, that by itself would not necessarily guarantee psychological continuity between the cerebrum recipient and its original owner. Psychological continuity is usually taken to involve the later instantiation of similar mental states to earlier ones. But there is good reason to think that the mental states that will be instantiated post-transplant will be radically different from any mental states instantiated before, at least according to Damasio (2010: 191), who claims that even mental experiences that take place largely at the cortical level, including the experiencing of internally generated images such as memories, and the perception of external objects, always occur through a modification of the proto-self. The proto-self, which is mainly instantiated in the brainstem, thus acts as a subjective perspective through which all mental states are filtered. It is therefore doubtful that a cerebrum transplant would preserve the psychological continuity required by psychological continuity theorists for the persistence of a person.

In contrast, the preservation of the brainstem itself, appropriately connected with the body which is continuously providing information relevant to its homeostasis, would suffice both for biological continuity of the human animal (since areas in the brainstem are responsible for coordination of essential life processes of the organism, such as respiration and heartbeat) and, arguably, for a minimal kind of psychological continuity, namely continuity of sentience. Although the decerebrated individual would most likely fall into a state of unresponsive wakefulness

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intelligent being can repeat the idea of any past action with the same consciousness it has of any present action; so far it is the same *personal self*' (1689/1997: II.xxvii.10).

syndrome (UWS)[29], there is empirical evidence that these individuals may be sentient (Panksepp et al. 2007; Pistoia et al. 2016). Interoceptive signals from various parts of the organism are relayed to the brainstem, where they are integrated to produce a felt map of the moment-by-moment state of the organism, which forms the basis of the proto-self (Damasio 2010: 190-195). This capacity of the organism to *feel* its own internal states – for example, the homeostatic imbalance produced by a change in osmotic pressure and sodium concentration which is perceived by the organism as the sensation of thirst (Denton 2005) – is not independent from the biological processes that constitute its life; it is part of how sentient organisms coordinate their life processes.

Although, strictly speaking, these observations concerning sentience make no difference to the animalist claim, if the persistence of animals such as ourselves involves at least a minimal kind of psychological continuity, in the form of continuity of sentience, it does make animalism more intuitively appealing. Most importantly, the proposed solution allows the animalist to reject the transplant intuition, which is the most important objection to animalism, on neuroscientific grounds, and avoids the problems faced by other replies currently found in the literature.

The considerations in favour of animalism presented here do not, evidently, settle the issue of personal identity once and for all. But animalism is a reasonable and compelling view that, at least from a naturalistic perspective, should be the default view of personal identity. It is a far more attractive theory than any of its rivals, being more parsimonious both in terms of the entities it admits into the ontology, and in terms of the complexity of its metaphysical requirements; it accords well with what science has to say about human beings, and some explicitly evolutionary arguments can be put forward in its favour, such as the animal descendants argument and the argument from evolutionary continuity of mental experience, in addition to other traditional arguments for animalism such as the thinking animal argument. Having shifted the burden of proof onto personalist views of personal identity, I conclude that the personalist objections to animalism, even in their strongest form, are not compelling.

Animalism is therefore a good starting point in an investigation of our metaphysical nature, and in the rest of the thesis I will assume that some version of animalism is true. There are problems with how animalism is usually formulated, however. Firstly, the main animalist claim is often insufficiently specified, and many animalists take different formulations of animalism to be equivalent, when they are not. Secondly, I argue that some formulations of animalism are false due to the nature of biological taxa. I'll start by looking more closely at what animalists actually say we are.

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[29] Formerly known as persistent vegetative state (PVS).

1.6. What are we, according to animalism?

Olson claims that animalism is primarily a response to the question of personal ontology, viz. the question ‘What are we?’, whereas personalism is primarily a response to the question ‘What are our persistence conditions?’, and personalists can sometimes be rather vague as to what kind of thing we actually are. Animalism, on the other hand, does not answer the persistence question per se but, “combined with an account of what it takes for a human animal to persist through time, it will *imply* an answer” (Olson 2015a: 85). In this thesis, I am interested in both questions – but they are not unrelated. Strong or essentialist animalism, however, will have more to say about our persistence conditions than weak or modest animalism, because it proposes to identify our *persistence kind*.

It is therefore important to clarify what kind of thing we are, according to animalism. Animalists say that we are animals, but this claim is often qualified. For instance, Snowdon (1991) says that we are “animals of a certain kind” (109); Olson (1997a) says that “you and I are animals: members of the species *Homo sapiens*, to be more precise” (17), but also, more simply, that we are “animals: biological organisms” (Olson 2015a: 84). Van Inwagen (1990) and Matthew Liao (2006, 2010), on the other hand, defend the slightly different view that we are essentially organisms.

As Blatti and Snowdon (2016) point out, the terms ‘animal’, ‘human animal’, and ‘organism’ are often used interchangeably in the animalist literature. For instance, in the same paper, Olson claims that we are: ‘members of the species *Homo sapiens*’, ‘living beings’, ‘living organisms’, ‘human animals’, and ‘human organisms’ (Olson 1995b). This may not be problematic; an animalist can truthfully claim that we are all of those things and more (e.g., ‘mammals’, ‘vertebrates’, etc). But the terms are not equivalent. While ‘human animal’, ‘human organism’ and ‘member of the species *Homo sapiens*’ do seem to mean the same thing – Olson says as much: “by ‘human organism’ or ‘human animal’ I mean simply “member of the biological species *Homo sapiens*”.” (Olson 1997a: 6) – ‘living being’ or ‘living organism’ have a much wider application – a fungus or a bacterium is just as much an organism as we are. Both ‘animal’ and ‘human animal’ refer to biological taxa, whereas ‘organism’ does not.

Rather than these being merely different ways of formulating the animalist view, there are in fact several candidates for our persistence kind, according to animalism. For instance, Olson (1997a) says that “[a]nimal (or *organism* or *human animal*) is a paradigm case of a substance concept, and so is an ideal candidate for determining a thing’s persistence conditions” (36). Similarly, Jens Johansson (2007) says that, according to animalism, our substantial kind may be *organism*, *animal*, or *human being*. So, there are at least three putative kinds for what we are, according to animalism. Since animalism is usually formulated as the claim that we are animals, it makes sense to start there.

1.6.1. Animals

Snowdon (1991), who coined the term ‘animalism’, stipulates than animalism involves two claims: “The first is that we are identical with certain animals. But it is also part of the view that our persistence conditions are those of *animals*, animals being regarded as one fundamental kind of thing” (111).

Olson has made it clear that by ‘animal’ he means, specifically, an organism of the animal kingdom (Olson 2015a: 1); “I mean by ‘animal’ what biologists mean by it: animals are biological organisms, along with plants, bacteria, protists, and fungi” (Olson 2007: 27). If this seems so obvious as to hardly be worth saying, it is nonetheless necessary to specify because others might defend an ‘ordinary sense’ of the word ‘animal’ which “means nothing but ‘animate being’ - a thing that can move and perceive” (Olson 2007: 27). Shoemaker (2011) claims that “ordinary folk”, when using the term ‘animal’, don’t intend to refer to “biological animals”, but instead refer to “things whose existence is constituted by the existence of biological animals” which are not necessarily “identical with the biological animals which constitute them” (364). But whatever these non-biological animals are supposed to be, they do not correspond to anything found in biology, and should be rejected within a naturalist ontology. In any case, it seems hardly credible that ‘ordinary folk’ in the twenty-first century have a concept of animal which is at odds with biology but, if they did, there would be no good reason to prefer it to the scientific concept.

In a survey of different kinds of animalism, Allison Thornton (2016) specifically questions what exactly is meant by ‘animals’ in the animalist literature. She asks “will any carbon-based, sentient life form do? If so, there could be a human person who is a dog (provided it’s intelligent enough) or one who is a Martian (as long as Martians are sentient and carbon-based)” (Thornton 2016: 522).[30] However, animalists might mean something more specific: anything from the species *Homo sapiens*, or perhaps from the genus *Homo*. In fact, although animalists claim that we are animals, that often turns out to mean, more specifically, *human* animals.

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[30] It is not clear why Thornton thinks being carbon-based is particularly relevant.

1.6.2. Human animals

Despite the name, animalism most commonly involves the claim that we are (identical to) not animals *simpliciter*, but human animals, or members of the species *Homo sapiens*. For instance, according to Blatti and Snowdon (2016: 2), animalism is the claim that we are identical to "an animal of a certain kind. That kind is what is called *Homo sapiens*". Bailey (2016) also considers animalism to be the claim that we are members of the species *H. sapiens*. Blatti (2020) considers than in the animalist's claim that we are animals, 'animals' refers to "biological organisms, members of the primate species *Homo sapiens*". According to Joungbin Lim (2019), standard animalists claim that we are animals essentially because "they believe that if we are animals, we are essentially members of the human kind (e.g. human animal, *Homo sapiens*), and as a result, we have the criterion of identity by virtue of that kind" (Lim 2019: 384).[31] Johnston (2016) characterises the most usual form of animalism as stating that "our most *specific* substance kind is *Homo sapiens*" (102).

Not all animalists consider 'human animal' to refer only to the species *Homo sapiens*. For instance, Mills (2008) considers human animal to mean "a member of the genus *Homo*", and similar suggestions appear in Thornton (2016) and op de Beke (2017). This interpretation seems more attuned to the biological view: textbooks on human evolution generally refer to *Homo sapiens* as 'modern humans', as opposed to 'archaic humans', comprising various extinct *Homo* spp. That these other species are considered, nonetheless, human, is reflected in the titles of books such as 'The Evolution of *Homo erectus*: Comparative anatomical studies of an extinct human species' (Rightmire 1993), 'The Humans Who Went Extinct: Why Neanderthals died out and we survived' (Finlayson 2009), and 'Lone Survivors: How we came to be the only humans on Earth' (Stringer 2012). These distinctions might matter little outside of palaeontology, because at present there is no other extant human species. But it is important to bear in mind that this was not always the case, and that 'human' is not as clear-cut a category as it might seem. It is merely a contingent fact, no doubt a consequence of our success in comparison to other closely related species, that there isn't a variety of different human species currently coexisting.

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[31] Lim (2019) rejects the essentialist claim.

1.6.3. Organisms

Some animalists bypass ‘animal’ and ‘human animal’ altogether, and defend the claim that we are essentially organisms. Van Inwagen (1990), for instance, states his animalist thesis thus: “I am an organism (in the biological sense)” (1990: 75). Liao (2006, 2010) claims that there are good reasons to believe that we are essentially organisms; for one thing, the Organism View “seems perfectly adequate for explaining the numerical identity of many beings that are non-human. Indeed, it seems fairly uncontroversial to hold that bacteria, plants and lower non-conscious animals are numerically identical to their organisms” (Liao 2006: 338). Organisms have the capacity to carry out, coordinate and regulate various life processes, such as “*metabolism, growth, assimilation, responsiveness, movement,* and *reproduction;* (…) *respiration, digestion, circulation, excretion, differentiation,* and so on” (336). Since we, too, coordinate and regulate various life processes, the Organism View should likewise be able to explain the numerical identity of human beings.

Of course, most other animalists also claim (or assume) that we are organisms, while also sometimes specifying precisely which organisms (i.e. animals, human animals). After all, animals are biological organisms, along with plants, fungi, bacteria, and so on. Therefore, according to animalism, “animals, including human animals, have more or less the same metaphysical nature as other biological organisms” (Olson 2007: 27). That animals are organisms seems to be no more than a truism, but of course, not everyone agrees.

Johnston objects to ‘animal’ and ‘organism’ co-referring.[32] In fact, he suggests that animals are constituted by organisms (Johnston 2007).[33] He conceives of ‘organism’ as being synonymous with the ‘body’ of the animal: “the animal that I am is not identical with my body. ‘My body’ denotes the organism that constitutes the animal that I am” (Johnston 2007: 55); and “organisms (bodies) constitute animals” (57).

‘Body’ is quite a complicated notion; Olson prefers to eschew it altogether, due to the amount of confusion it generates.[34] On the other hand, the strange notion that animals are not organisms seems to be derived from facts about animal development. Johnston (2007) says that “after my conception it took me some time to develop into an animal. For a while, I was a multi-celled organism – a pre-fetal embryo – wholly parasitic on my mother. I developed into an animal, and was not always an animal” (53). This is not a novel idea. Snowdon (1991), one of the earliest

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[32] In the case of animals, that is; obviously they don’t co-refer for organisms that are not animals.

[33] This is reminiscent of Shoemaker’s claim of animals in one sense being constituted by animals in another sense.

[34] See §6.2.5 for discussion of multiple meanings of ‘body’.

proponents of animalism, has this to say about what he considers to be a problem with animalism: “If we say that we were, prior to birth, foetuses, then according to animalism as presently stated, we must count the foetus as an animal. This is not an entirely happy thing to say.” (111). It is curious to note that Olson (1997b) defends this very feature as an advantage of animalism over rival views. Snowdon concludes that

> “It may, therefore, be correct to treat being an animal as what is known as a phase-sortal, covering certain stages in the life-history of, say, the more general category of organisms, which, if they are like us, will normally go through a pre-animal-, and then a much longer animal-, phase.” (Snowdon 1991: 111)

But, surely, the embryo is an animal embryo. The foetus is a developmental stage of an animal. It is indeed arguable whether the animal begins at conception (see §5.3.1), but the same is true of the multicellular organism. An animal *is* a multicellular organism; it is not *constituted* by one. It makes no sense to say that something is first an organism and then becomes an animal; the animal simply is the organism. What we should say instead is that the animal, which is a multicellular organism, emerges at some point during development (see §5.3.2 for discussion).

1.7. Conclusion

In this chapter, I have clarified the question ‘what are we?’ and identified the kind of answer that would be adequate. I introduced the naturalistic metaphysics framework and argued that, from this perspective, animalism should be the default view in the personal identity debate. I discussed several arguments for animalism, as well as some objections, and concluded that animalism is a good starting point for an investigation of our metaphysical nature. This, however, does not settle the question of what kind of thing we are, especially since animalists have variously claimed that we are (1) animals, (2) human animals, and (3) organisms. I briefly discussed what is meant by each of these, and, in the next chapter, I assess the suitability of the first two as possible answers to the question ‘What kind of thing are we?’.

CHAPTER 2

Biological Taxa

Two of the most popular animalist answers to the question of what we are, namely ‘animal’ and ‘human being’, refer to biological taxa. This chapter assesses their suitability as answers to the question ‘what kind of thing are we?’. §2.1 discusses whether biological species are natural kinds, and §2.2 discusses this in relation to higher taxa. I argue that biological taxa are either not natural kinds at all, but complex individuals or, if they natural kinds, they can only be defined by extrinsic properties. Furthermore, organisms do not belong essentially to their taxa. §2.3 introduces the question of essential membership, §2.4 argues for the contingency of species membership, and §2.5 presents a new argument for the contingency of higher taxa membership. I conclude that biological taxa are not persistence kinds, but argue that strong animalism can be maintained if formulated as the view that we are organisms (§2.6). §2.7 concludes the chapter.

Sections §2.3. to §2.5 of this chapter appear with slight changes in the following publication:
Hermida (2022). Cats are not necessarily animals. *Erkenntnis,* forthcoming.
https://doi.org/10.1007/s10670-022-00588-w

2.1. Are biological species natural kinds?

Both animalists and their opponents assume that ‘animal’, ‘human animal’, and ‘organism’ are natural kinds. Olson, for example, admits that, throughout his defence of animalism, he has

> “relied on the assumption that animal, or at any rate human animal, is a natural kind and therefore a substance concept, and that any animal has the persistence conditions that it has by virtue of being an animal, or by virtue of being an animal of a particular biological species, such as a human animal” (Olson 1997a: 121).

But are these natural kinds and, furthermore, does something have the persistence conditions it has in virtue of being an animal, or in virtue of being an animal of a particular species? I will argue that neither is the case.

Before Darwin, and for quite some time after, biological species were considered, in the philosophical literature, to be paradigm examples of natural kinds. On the traditional view, going back to Plato and Aristotle, natural kinds are universal kinds, defined by intrinsic, unchangeable essences, and these essences explain the properties of things of that kind. Both Putnam and Kripke assume intrinsic essentialism about species when they claim that a lemon in something that has the genetic code of a lemon (Putnam 1975: 158), or that what makes something a tiger is its internal structure (Kripke 1980: 120-121).

Kind essentialism has three main tenets: first, that all and only members of a kind have a common essence; second, that the essence of the kind is responsible for the traits typically associated with members of the kind; and third, that knowing a kind’s essence enables us to explain and predict the properties exhibited by members of the kind (Ereshefsky 2022). All of these are problematic when applied to species; but especially the first two.

To start with, species evolve gradually and have vague boundaries, both in time and space. Secondly, it is impossible to find a common intrinsic essence that is shared by all members of a species but not by members of any other species. Although conspecific organisms share a large number of genes and phenotypic features, most of these are also shared by members of closely related species. Much to the surprise of traditional essentialists about species, there are simply no genes that are shared by all and only members of a given species (Okasha 2002: 196–197).

Consider a property that is taken as characteristic of a given species. Having black plumage is a property of the species *Corvus corax*, the common raven. Is it an essential property? Well, most ravens are in fact black, whereas most other birds are not, so at first sight, it seems promising. However, we soon find that “black feathers are commonly shared among many Corvid species” (Lee et al. 2016: 96). It also emerges that ‘black feathers’ is not a single feature, but the result of the intensity of melanin production, the relative thickness of the barbs and barbules of the feathers, and the production of ‘structural colouration’, involving glossiness or iridescence (Lee et al. 2016). As it turns out, the generalisation “all ravens are black” is also false. Until the early twentieth century, ravens from a population in the Faroe Islands frequently presented a ‘white-speckled’ phenotype (van Grouw 2014). Variation is the norm in biology. It is a feature of biological species that the organisms that compose them are not exact copies of each other; in fact, it is precisely this variation that allows for evolution by natural selection.

Even if were the case that all ravens were black, this would still not count as an essential property, because, at any moment, ravens of a different colour could potentially evolve, without speciation, and we would simply have to amend our descriptions of them. Consider, for instance, what David Hull says about swan:

> "Right now all specimens of *Cygnus olor* are white. No doubt the type specimen of this species of swan is also white. However, if a black variety were to arise, *Cygnus olor* would not on that account become a new species. Even if this variety were to become predominant, this species would remain the same species and the white type specimen would remain the type specimen. The species description would change but that is all." (Hull 1978: 353)

This is why Mark Ereshefsky (2022) considers the universality of any biological trait in a species "fragile". Thus, "[e]ven if a species were found in which some characteristic is shared by all and only the organisms that are in the species, this could not be counted as a species essence" (Sober 1980: 380).

Due to the problems with applying the traditional natural kinds framework to biological species, a more promising approach is to consider them as complex individuals.

2.1.1. Species as individuals

In a 1966 paper, Michael Ghiselin remarked that "biological species are, in the logical sense, individuals", and the names of species are proper names (Ghiselin 1966: 208-9). The species-as-individuals theory was further developed by Ghiselin (1974) and Hull (1976, 1978) in a series of papers. The argument goes something like this: natural kinds are spatio-temporally unrestricted kinds whose instances satisfy a set of necessary and sufficient conditions for being members of that class. Individuals, on the contrary, are particulars – they are spatio-temporally restricted, have a beginning and an end, and do not have instances, but parts. It is a feature of individuals that no properties are necessary and sufficient to define them. All these things which are true of individuals are true of species, which are therefore not kinds. It follows that the names of biological species are proper names.

Species are composite wholes, 'breeding communities' which cannot be defined by any intrinsic properties of their members, whether morphological, genetic, or physiological (Ghiselin

1974: 539). They are not collections of organisms grouped by similarity. From the point of view of evolutionary theory, “it is the causal nexus that matters” (Ghiselin 1974: 539). Species function as units of evolution, and for this “they need not be composed of similar organisms; instead they must be made up of organisms related by descent” (Hull 1976: 174). In fact, intraspecific variability is an important feature of species. Species also exhibit a certain degree of unity, which allows them to participate in the evolutionary process; this unity involves, for example, gene exchange and reproductive competition.

As mentioned above, if species are individuals, the names of species are proper names, and the only way to define them is “ostensively, in a manner analogous to a christening” (Ghiselin 1966: 209). This is exactly how species are named: a ‘specimen’ is selected to be the type-specimen, and the species is defined on the basis of conspecificity with the type-specimen. Crucially, the type-specimen does not need to be in any way ‘typical’; in fact, it is hard to see what a typical specimen would be for species with significant sex dimorphism. The type-specimen is not intended to be ‘a good example’ of a kind, it is merely something one can point to and say: ‘the species of which this organism is a part’. As Hull (1976) explains, “[t]he fact that any specimen, no matter how atypical, can function as the type-specimen makes no sense on the class interpretation; it makes admirably good sense if species are interpreted as individuals” (175).

When a species is described, a list of diagnostic features is also published. But these are not necessary and sufficient conditions for something to belong to that species; they are merely epistemic aids for taxonomists, because the organism’s actual genealogy or its reproductive compatibility to other organisms might not be epistemically available to the researcher. As Okasha (2002) explains, “[t]he “superficial” morphological traits which taxonomists use to delimit species in practice are not the ultimate determinants of species membership, but rather fallible indicators” of the organisms’ “position in the tree-of-life, which is the real criterion” (202).

Natural kinds are supposed to be spatio-temporally unrestricted. Electrons, for instance, can come into existence anywhere in the universe, and they will be qualitatively identical to the ones we are familiar with. Biological species, however, are spatio-temporally restricted. They have a definite beginning (speciation) and end (extinction), and cannot emerge in multiple locations. If an organism were to evolve on another planet, independently from Earth-life, that looked exactly like an elephant, it would not be an elephant, because it would not be genealogically related to Earth elephants.

Overall, the species-as-individuals thesis is possibly the most compelling solution to the problems of trying to fit biological species into the traditional natural kinds framework. More recently, alternatives to the species-as-individuals conception have emerged, which try to navigate a sort of middle ground between being consistent with evolutionary theory, taking into account facts such as intraspecific variability and the importance of genealogy, while at the same time re-importing a degree of essentialism back into the notion of species as a natural kind. The so-called 'new essentialism in biology' has two main forms: homeostatic property cluster kinds and intrinsic biological essentialism.

2.1.2. Species as homeostatic property cluster kinds

The theory of homeostatic property cluster kinds (HPC kinds) was mainly developed by Richard Boyd (1999), and went on to garner some popularity within philosophy of biology. HPC theory considers natural kinds to be groups of things characterised by a stable cluster of properties that tend to co-occur; no single property of the cluster is necessary, but a subset of such properties is sufficient for kind membership. This property cluster is the result of homeostatic mechanisms: either some properties tend to favour the presence of the others, or a common mechanism causes both to co-occur (Boyd 1999). For biological species, the homeostatic mechanisms suggested include gene exchange, reproductive isolation, common selective factors, coadapted gene complexes, and developmental constraints (Boyd 1999: 165). These mechanisms supposedly produce a sort of 'evolutionary stasis' which maintains the cluster of properties exhibited by the species.

Although HPC theory is more compatible with evolutionary biology than traditional essentialism, it has several problems. The assumption that species must be assemblages of organisms that share many properties in common leads to what P. D. Magnus (2012) dubs 'similarity fetishism', which is a feature of HPC theory that brings it into conflict with biological practice. While the members of a species share many similarities, they also have persistence differences, or stable polymorphisms (Ereshefsky & Reydon 2015). These differences include, for instance, sexual dimorphism, morphological differences between stages of the life cycle, between castes in social insects, and alternative male morphs. On the other hand, similarity can be misleading, as in the case of cryptic species.

It is telling that, even while explicitly accommodating evolutionary biology, HPC theory has a need to invoke the concept of 'evolutionary stasis'. The idea that species spend most of their existence in a state of 'stasis' comes from Stephen Jay Gould and Niles Eldredge's (1977) theory of punctuated equilibrium. While species can remain in 'stasis' for extended periods of time under stabilizing selection, this is not the case for all species, and might not even be true of a majority of them (Ridley 2004). Examples can be found in the literature for both punctuated equilibrium and gradual evolutionary change (see Ridley 2004: chapter 21, and references therein). Casetta and Vecchi (2021) argue that "developmental homeostasis canalises the development of the organisms of the species by making them phenotypically uniform, while genetical homeostasis (i.e., stabilizing selection eliminating less fit hybrids and 'deviant' organisms) has an equivalent genetic effect" (S3018). With its emphasis on similarity, HPC ends up subscribing to a kind of 'typological thinking' (Mayr 1975), which sees 'deviant' organisms where evolutionary biologists see normal intraspecific variability. On the contrary, intraspecific variability is so valuable (not to mention indispensable for evolution), that organisms go to great lengths to *increase* variability in their offspring, for example by actively seeking additional mating opportunities, so as to produce more diverse, *not* more genetically homogeneous, offspring.

Ultimately, the main problem with HPC theory lies in its conception of biological taxonomy, which does not conform with scientific practice. Indeed, in biology, "[o]rganisms are not included in the same species because they are similar to the type specimen or to each other but because they are part of the same chunk of the genealogical nexus" (Hull 1978: 353).

According to Boyd, "[t]he naturalness of natural kinds consists in their aptness for induction and explanation" (1999: 147), which explains why he doesn't see how the value of taxa could rely solely in "representing patterns of ancestry and descent" (182). This is echoed in Paul Griffiths's (1999) claim that "a kind is (minimally) natural if it is possible to make better than chance predictions about the properties of its instances" (216). This is a very sensible picture of natural kinds and their usefulness for science, but HPC theorists seem to take it for granted that *species* are the crucial units biologists need to use for the purposes of explanation and prediction (e.g. Boyd 1999).

This is a widely held belief in philosophy. Thus, for example, Michael Strevens (2012) confidently asserts that "is difficult to avoid the conclusion that, for example, ravenhood will figure somewhere in the explanation of the fact that all ravens are black" (757). In fact, the explanation for why *most* ravens are black has nothing to do with 'ravenhood', but involves physiological (what pigments are produced and how), genetic (what genes code for which proteins that play a role in the physiological process), physical (how certain pigments and structural properties of feathers interact with light, how they generate iridescence, etc), distribution (in which organisms do these genes occur, in which areas of the developing bird are they expressed), and evolutionary explanations (the birds that share this feature are genealogically related).

On the other hand, many things in biology which are neither species nor higher taxa feature in explanation and prediction; for instance: males, larvae, organisms with a certain gene, predators, heterotrophs, etc. By comparison, species and higher taxa are remarkably poor guides for explanation and prediction; their main function is to *localise* organisms on the phylogenetic tree of life on Earth (Reydon 2019).

2.1.3. The 'new' biological essentialism

Despite the rejection of intrinsic essential properties in biology, some authors have recently tried to make them more palatable. Michael Devitt (2008, 2021, 2023) argues that species have at least partly intrinsic essences that "are probably largely, although not entirely, genetic" (2008: 650). Travis Dumsday (2012: 493), who also argues for intrinsic biological essentialism, provides a helpful list of the different kinds of intrinsic essences that have been postulated by different authors, including genetic, morphological, developmental, and others.

Devitt considers the fact that there are true generalisations about the morphology, physiology, and behaviour of members of a given taxon (2008: 654), and then asks: what makes these generalisations true? He then reasons that "[t]here has to be something about the very nature of that group (…) that, given its environment, determines the truth of the generalization". And, he concludes, "[t]hat something is an intrinsic underlying, probably largely genetic, property that is part of the essence of the group. Indeed, what else could it be?" (Devitt 2008: 655). Devitt is here conflating the fact that organisms have certain genes, developmental processes, etc, which, given a certain environment, cause them to produce a certain phenotype, with something very different, which is the distribution of those genes, etc, among organisms. None of those genes, developmental mechanisms, etc, confers membership in a given taxon, nor is the membership in a taxon a guarantee that the individual organism will have those specific genes.

Consider Ereshefsky's explanation of why a zebra is striped:

> "In its embryonic state, a zebra has an ontogenetic mechanism that causes it to develop stripes. That developmental mechanism is neither necessary nor sufficient for membership in Zebra. Some zebras lack that mechanism. Moreover, the developmental mechanism that causes stripes in zebras causes stripes in a variety of animals, including cats." (Ereshefsky 2022)

The problem with the essentialist view of taxa is not with the idea of essence *per se*, as the intrinsic properties in question may be essential for individual organisms; the problem is that “the intrinsic properties that cause organismic traits do not coincide with taxonomic boundaries; they cross-cut such boundaries” (Ereshefsky 2022).

For essentialists, variability within species is something to be explained or downplayed – “apparent exceptions” (Devitt 2008: 659) – while highlighting similarities or common properties. The individuals who lack a property which is very common for their species are seen as somehow ‘defective’, ‘deviant’, or even ‘monsters’ (Devitt 2008: 659); they are less good examples of their kind. Viewing species as evolving populations, however, implies seeing individual differences not as “the effects of interfering forces confounding the expression of a prototype”, but rather as “the causes of events that are absolutely central to the history of evolution” (Sober 1980: 371).

2.1.4. Relational essentialism

While essentialist accounts of species as natural kinds with intrinsic essences (including HPC theory) clash with biological practice and fail to provide an adequate account of species as evolving entities, there is one kind of essence that is compatible with evolutionary theory: extrinsic essences involving relational properties. This form of relational essentialism is defended by Okasha (2002), who argues that all accepted species concepts in contemporary biology – including interbreeding concepts such as the biological species concept, phylogenetic species concepts, and even ecological species concepts – use relational properties, such as ‘being reproductively compatible with’ and ‘being genealogically descended from’, as the criterion of conspecificity.[35] Relational essentialism is the only essentialist approach that is compatible with biological practice: biologists do in fact classify organisms based on these relations, rather than on any intrinsic properties – although intrinsic properties, such as genetic composition, can be used as *evidence* of the holding of the relevant relations.

Kripke and Putnam were partly right, then, in supposing that whether or not an organism belongs to a given species is not determined by features such as “[t]he ‘superficial’ morphological traits which taxonomists use to delimit species in practice” (Okasha 2002: 202), but they were wrong in assuming that some ‘hidden structure’ was what determined species membership; rather, a relational property does. Most natural kind essentialists think that the essence of a natural kind must

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[35] Griffiths (1999) also defends a form of relational essentialism, but combined with an HPC account.

play two roles: it must determine the criterion of membership for belonging to the kind, and also be causally responsible for the presence of the superficial features of members of the kind. But although in the case of, say, chemical elements, the two roles are indeed played by the same thing – the 'hidden structure' which is the microstructural essence of the kind – there is no reason why the same thing should always have to play both roles. When the determinants of kind membership are relational, as is the case with biological species, these two roles are played by different things (Okasha 2002: 204).

Ereshefsky (2010) concurs that "intrinsic properties are not part of a taxon's membership conditions, and relational essentialists are right about how biologists individuate taxa" (682); however, he resists considering relational essentialism as a form of essentialism because he thinks that the explanatory requirement is no less important a commitment of essentialism than the membership requirement (682-683). In fact, Ereshefsky does think that "the relations that serve as identity conditions of a taxon play some role in explaining the typical traits among a taxon's members", but that this role is weak, and cannot support what he sees as the main explanatory aim of essentialism, which involves "[discovering] essences that are central in explaining the typical traits of a kind" (2010: 683).

While relational essences cannot play the explanatory role the essentialist would want them to (i.e., to explain the particular phenotypic features of the organisms belonging to a given species), they do explain why these organisms share certain features (because they are related to each other). Evolutionary theory and facts about the evolutionary history of each lineage will also explain why these particular traits are present in a certain species.

Okasha's (2002) theory is noncommittal as to whether species should be conceived of as natural kinds or individuals, which he sees as "largely a matter of convention" (193). But one might say that it applies even better to species conceived of as individuals:

> "Kripke (1972) has suggested that each individual human being has the essential property of being born of precisely the sperm and the egg of which he or she was born. If such individuals as organisms have essential properties, then it will presumably also be possible for individuals like *Drosophila melanogaster* to have essential properties as well. Of course, these essences will be a far cry from the "purely qualitative" characteristics which traditional essentialism thought it was in the business of discover" (Sober 1980: 360)

If species are individuals, then to say that an organism belongs to a certain species is not to say what kind of thing it is; it is simply to locate its *position* on a phylogenetic tree. If someone claims that she is essentially a member of the species *Homo sapiens*, she is merely stating the fact that her parents were members of the species *H. sapiens*, that she is more closely related to certain primates than to garden snails, etc. Does this answer the question ‘What are we’? That depends on what sort of answer is required; it seems to me, anyway, that we want to know what *kind* of thing we are, and not merely how closely related we are to certain other organisms. And although stating our position on a phylogenetic tree is informative in many ways, it does not tell us what kind of thing we are; nor is it indicative of our persistence conditions.

If, on the other hand, species are natural kinds, then they can only be natural kinds defined by extrinsic, relational essences – which is the only essentialist view compatible with biological practice. And it is hard to see how natural kinds that are exclusively defined by extrinsic properties, such as ‘being descendant from’ and/or ‘being reproductively compatible with’, could be informative regarding an object’s persistence conditions.

2.2. Higher taxa

If we grant that biological species are individuals, ‘animal’ might seem to be a good alternative for a persistence kind. But is ‘animal’ a natural kind? It has certainly been assumed to be. As we have seen, Snowdon (1991: 11) considers ‘animal’ to be a “fundamental kind of thing”, and Olson (1997a) confidently says “I know of no philosopher who has ever argued explicitly, for any reason, that *animal* is not a natural kind” (122). Since animalists such as Olson consider ‘animal’ to mean what it does in biology, i.e. “an organism of the animal kingdom” (2015a: 1), I will consider that to be the main view to take into account, and will disregard possible interpretations of ‘animal’ that appeal to ordinary language, or conflict with biological science.

In *The Animal Kingdom: A Very Short Introduction*, Peter Holland (2011) lists several features of animals: they are multicellular; they are heterotrophic, acquiring energy by eating other organisms; they can move and sense their environment; they produce sperm and egg cells of different sizes, and they have epithelial cells (1–2). Other authors emphasise different features, such as the presence of collagen.

However, as Holland clearly states, these are all “criteria by which we recognize animals” (2011: 3); none of these properties define animals. ‘Animal’ can no more be defined by necessary and sufficient properties than a biological species can. Animals constitute a clade, a monophyletic group descended from a common ancestor; this clade is called the Animal Kingdom or Metazoa.

Thus, the term ‘animal’ “cannot be applied to living organisms from elsewhere in the evolutionary tree, even if they possess some animal-like characters” (Holland 2011: 4). For instance, cellular slime moulds form slug-like moving structures, and carnivorous plants acquire energy from eating other organisms, but neither can be called animals, since they are located elsewhere on the phylogenetic tree. The converse is also true: some animals have lost distinct gametes over the course of evolution, but they do not cease to be animals because of that. Organisms simply cannot migrate out of the clades they belong to. For the same reason, there could not be alien animals, even if we were to find extraterrestrial organisms sharing many features with Earth animals.

Like species, higher taxa have also traditionally been seen as natural kinds. For instance, Lowe says that mammals “comprise a natural kind, in virtue of there being such distinctively mammalian laws as that mammals are warm-blooded and that they suckle their young.” (1989: 6). This will not do, because even if these features are true of every actual mammal, a species lacking one of these characteristics could evolve; yet it would still be a mammal. For instance, birds are characterised by having wings, but some flightless birds have lost them over the course of evolution; yet they are still birds.

Other authors maintain that only species are ‘real’ in the sense of not being merely human-made categories, and that higher taxa are merely conventional, or nominal kinds. But it is hard to see how taxa higher than species could be natural kinds: like species, higher taxa have no essential intrinsic properties, feature in no laws of nature (*pace* Lowe), are spatio-temporally restricted, and the parts that compose them are all related by descent. Unlike species, their members are not even particularly similar.

After a period of time in which there were several competing theories, biology finally caught up with Darwin (1859) – “all true classification is genealogical” – and settled on phylogenetic classification, following Hennig’s (1966) principles. Phylogenetics aims to identify real taxa, i.e. taxa that exist in nature, independently of human interests (Wiley and Lieberman 2011: 68). These are almost always monophyletic clades. A monophyletic clade is a group of organisms which includes an ancestor species and all its descendants. Natural taxa have to be discovered; they cannot be invented, although they can be named. Clades, i.e. monophyletic groups, as defined by Hennig (1966) emerge in nature as a result of the evolutionary process, in particular, due to speciation (Wiley and Lieberman 2011: 68).[36]

Like species, higher taxa are also better regarded as individuals (Griffiths 1974; Hull 1978; Patterson 1978; Wiley and Lieberman 2011: 73); they are “chunks of the genealogical nexus” (Hull

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[36] See further detail on phylogenetic classification in Appendix 1.

1978); historical individuals, although less cohesive than species. The names of higher taxa are also regarded as proper names (although there are many more clades than the ones that have been named).

While homeostatic property cluster theory might have some plausibility in the case of species, the case for HPC higher taxa is weak. In fact, in higher taxa, homeostatic mechanisms which might promote clustering of properties are almost completely lacking since the different parts of a clade do not normally exchange genes. There is a serious lack of fit between monophyletic clades and property clusters. This lack of fit is recognised by Boyd, who nevertheless proposes to “reconceptualize monophyly” (2010: 694), rather than abandon the HPC account of higher taxa. Furthermore, the conception of higher taxa held by HPC theorists – that taxa are natural kinds that figure in the explanation of phyletic inertia (Rieppel 2005; Boyd 2010) – seems too far from the biological conception – that taxa are natural groups of organisms related by descent. This emphasis on inertial constraints on evolvability regarding higher taxa mirrors the emphasis on evolutionary stasis regarding species, under HPC theory. But although new clades can indeed exhibit phylogenetic inertia, they also open up new avenues of evolvability. Consider, for example, the evolution of multicellularity in animals, and the dramatic increase in diversity of body plans that occurred in the Cambrian explosion.

If higher taxa, which are monophyletic clades, are complex individuals, and not kinds of things, it seems that ‘animal’ cannot serve as the kind under which to express the animalist thesis. In stating what we are, there seems to be no good reason to prefer the taxon ‘animal’ to ‘vertebrate’, ‘mammal’, or ‘primate’. In fact, no taxonomic divisions are privileged. When Johnston (2016: 102) contrasts animals with plants, angels, and immaterial souls, he seems to regard plants as something fundamentally different from animals. Indeed, we are quite far away from plants in the phylogenetic tree.[37] But there is also a clade which includes both plants *and* animals (and fungi). Ultimately, all life on Earth is related, forming a very large monophyletic clade which shares a common origin and can also be regarded as an individual (Hermida 2016). I have termed this kind of super-clade an *independently originated life clade*, or IOLC, of which Earth-life is the only known example so far (Hermida 2022). Yet neither the smallest, nor the largest clades qualify as natural kinds.

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[37] As it happens, animals are more closely related to fungi than either are to plants.

2.2.1. Objection: taxa must be natural kinds because they are explanatory

Some authors argue that biological taxa must be natural kinds, because they are explanatory. For example, Griffiths (1997) argues that biological taxa are natural kinds because they are "nonarbitrary ways of grouping natural phenomena", and they are nonarbitrary because "they have some degree of projectability. Observations about them can be projected onto new instances with better than chance results" (213). While these observations are certainly true, it does not follow that taxa are natural kinds. On the contrary, I suggest that: (i) taxa are indeed nonarbitrary groups, but not because they have some degree of projectability (if anything, it's the other way around); (ii) taxa are less explanatory than usually thought; and (iii) the explanatory role they do have is connected to their primary function of locating organisms on the phylogenetic tree.

LaPorte (2004) argues that taxa are natural kinds because they have explanatory value:

> "[A] natural kind is a kind with explanatory value. A lot is explained by an object's being a polar bear. That it is a polar bear explains why it raises cubs as it does, or why it has extremely dense fur, of why it swims long distances through icy water in search of ice floes. Similarly, there are theoretically satisfying answers as to why polar bears on the whole raise cubs as they do, or have dense fur, or swim for miles through icy water. The polar bear kind is a useful one for providing significant explanations. It is a natural kind." (LaPorte 2004: 19).

Firstly, an object's being a polar bear implies that it is an organism. A lot is explained by an object's being an organism (it is alive, it behaves in such a way as to acquire nutrients, it expels waste materials, etc). But let us consider the polar bear more specifically.

Is 'why it raises cubs as it does' explained by 'an object's being a polar bear'? Not unless the polar bear is female, and the cubs are hers. The explanation of why a polar bear raises cubs as it does, moreover, includes multiple aspects (why only the female provides parental care, why it nurses her cubs for an extended period with highly nutritious milk, why it protects and is affectionate towards them, why it teaches them hunting skills, etc), all of which have detailed explanations well grounded in evolutionary theory, and none of which is unique to polar bears. In fact, most of these features are to be expected of a large predatory animal with internal gestation, which lives in a very cold habitat, and produces few offspring at a time.

As to why it swims for miles through icy water to find ice floes; polar bears mainly prey on seals, either sneaking up on them while they are resting on the ice, or capturing them through breathing holes. The ice/air interface is essential for capturing seals, as the polar bears are unable to capture them in the water (unlike sharks, for example). Two things do the explanatory work here: features relating to the prey (namely, where they can be found), and a hunting strategy adequate for a terrestrial animal to hunt a secondarily aquatic large animal which needs to come up periodically to breathe. Again, the hunting strategy is not specific to polar bears; for instance, Inuit traditional hunters use a remarkably similar technique for capturing seals (Peter et al. 2002).

It is not that taxa cannot serve as the inferential basis for true generalisations about the organisms included in them; in fact, both species and higher taxa are ‘families’ of organisms related by common descent. Evidently, more closely related organisms tend to share more features in common than less closely related organisms. What taxa provide is the *location* of organisms on the phylogenetic tree (Reydon 2019). This can help us identify traits they are more likely to have based on the traits exhibited by closely related organisms: “[i]f we observe a property in an organism, we are more likely to see it again in related organisms than in unrelated organisms” (Griffiths 1999: 220). Our inferences are indeed more likely to hold for more closely related organisms. Nevertheless, generalisations about taxa still amount merely to probability distributions, not laws of nature (for instance, most mammals have fur, but not all; most members of the class Carnivora have carnivorous diets, but panda bears do not; etc).

Often, the inferential basis is not even the taxon we are considering: it can be a higher taxon (all mammals, not just polar bears), a subset of the taxon (female polar bears), or of a larger taxon (female mammals), or even a functional kind (predators). And once again, these generalisations will not constitute laws of nature (e.g. most male mammals do not provide parental care to young, but some do; and while all female mammals produce milk, this trait could be lost in a possible future mammal species).

While there may be laws of nature in biology, they cannot feature specific taxa. That would be like trying to discover laws of nature about a particular family. While members of the same family have many features in common (because they are closely related), no generalisations about them could amount to a law of nature. For instance, suppose that every member of the Smith family has a genetic propensity for obesity. Still, the next baby could be born without that gene, either due to recombination or mutation. Similarly, while all members of a taxon share features in common, that is merely a contingent fact about the distribution of certain traits in a group of organisms.

Taxa, Thomas Reydon (2019) argues, hold relational information about organisms, i.e., information about their location on the phylogenetic tree; they do not convey intrinsic information about the properties of the organisms that belong to the taxon. Taxa are “location markers”, which help us make inferences about other organisms located nearby on the tree (Reydon 2019). Waters

(1998) argues that there are two kinds of generalisations in biology: causal generalisations, concerning biological natural kinds; and historically based generalisations, concerning the contingent distribution of traits among organisms that emerges over the course of evolution. While taxa do store information about organisms, their epistemic role is different from that of kinds of organisms (Reydon 2019: 22); it consists in capturing the pattern of ancestry and descent in evolutionary history (an epistemic aim in its own right) and, in doing so, they also provide the basis for *distribution* generalisations, which can inform us of which traits are more likely to be present in which organisms in virtue of their of relatedness.

2.2.2. Objection: there are different kinds of organisms

Another possible objection to the view that biological taxa are not natural kinds comes from the observation that there are different kinds of organisms. In a paper defending intrinsic biological essentialism against the mainstream view that taxa are defined relationally, Dumsday (2012: 487-488) advances the following argument: (1) 'organism' is a natural kind; (2) members of the kind organism are members by virtue of intrinsic properties; (3) if membership of a kind consists of intrinsic properties, then membership of sub-kinds of what kind must also consist at least partly of intrinsic properties; (4) if the kind 'organism' has sub-kinds, they must have identity conditions consisting at least partly of intrinsic properties; (5) the generic kind 'organism' has sub-kinds; and (6) therefore these sub-kinds must have identity conditions consisting at least in part of intrinsic properties.

Dumsday starts with the observation that 'organism' is a kind of thing. By that he means that "there is a real distinction in kind between living and non-living things" (Dumsday 2012: 488). And this natural kind is indeed defined by intrinsic properties. He quotes from biology textbooks that highlight several intrinsic properties of life, including organisation, homeostasis, reproduction, metabolism, responsiveness, and adaptation. Notwithstanding the difficulties of defining life, the idea that 'organism' is a natural kind defined by intrinsic properties seems an eminently acceptable premise (see §2.6). So premises (1) and (2) are relatively uncontroversial.

It is when we get to premises (3) and (4) that we get into trouble. Dumsday (2012) claims that *if* the kind 'organism' has sub-kinds, *then* they must have at least some intrinsic properties. This should be accepted. After all, if organisms have essential properties, then if something is a kind of organism it must, at the very least, have the essential properties of organisms. But he has not provided a reason why the sub-kinds of a natural kind must have any *additional* intrinsic properties in common. Furthermore, Dumsday assumes that, if there are sub-kinds of the kind ‘organism’, then those sub-kinds must be taxa – what else could they be? He suggests ‘eukaryote’ as an example of a more specific sub-kind falling under the generic kinds ‘organism’. But ‘eukaryote’ is not a kind of organism; it is a phylogenetic group: eukaryotes are a chunk of the phylogenetic tree (or, perhaps more adequately, web) of life on Earth, which emerged at a particular time in the history of life on this planet, having resulted from the symbiotic fusion of different prokaryotic species, one of which (an α-proteobacterium) became the ancestor of the mitochondria that power eukaryotic cells.[38]

In other words, there are no alien eukaryotes. We could perhaps define a functional kind ‘nucleated cell’, which could then be applied to any nucleated cells that evolve anywhere in the universe, eukaryotic or otherwise. But that of course is not a taxon. The fact that the word ‘eukaryote’ means something like ‘true nucleus’ does not mean that having a nucleus is a necessary identity condition for eukaryotes. If some eukaryote species were to lose the nucleus, they would still belong to the Eukaryota. Another important feature of eukaryotes is the presence of mitochondria; yet, recently, a eukaryotic species was discovered which lacks mitochondria altogether, having secondarily lost them in the course of evolution (Burki 2016). Yet this organism – the microbe *Monocercomonoides* sp., which inhabits the digestive tract of several animals – is still a eukaryote since, no matter how different they become, the descendants of the members of a clade continue to be part of that clade.

So what are some bona fide sub-kinds of organisms? Two good examples are unicellular and multicellular organisms (Liao 2006). Cellular structure is a very important feature of organisms. Unsurprisingly, these kinds do not map well onto taxa, since multicellularity has evolved multiple times in different groups. But that is not a drawback; their very universality bolsters their credentials as genuine natural kinds. For instance, we might one day discover unicellular organisms on Mars, lacking any common descent with Earth organisms. Dumsday (2012) also mentions particular modes of metabolism or reproduction as possible intrinsic essential properties of biological kinds. Mode of metabolism is in fact an excellent way of classifying organisms, and one that is highly useful in ecology, biochemistry, and astrobiology. For instance, organisms can be classified as autotrophs or heterotrophs, depending on how they obtain carbon, and as photo-, litho-, chemo-, or organotrophs, depending on the energy source (Dartnell 2007: 18).

Dumsday is partly right, then, in that it is legitimate to be ‘pluralist’ about classification: phylogenetic classification is not the only classification. Non-phylogenetic classifications of

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[38] The fact that eukaryotes evolved through symbiosis rather than branching does not preclude them forming a clade. See Wiley and Lieberman (2011: 4).

organisms are important in several areas of biology (Ereshefsky & Reydon 2015). But intrinsic properties cannot be used in phylogenetic classification, which needs to be strictly genealogical to capture the actual evolutionary history of life on Earth.

2.3. Do organisms belong essentially to their taxa?

In the previous sections, I argued that species and higher taxa are not natural kinds, or else they are spatio-temporally restricted natural kinds defined by relational properties. A distinct question is whether organisms belong essentially to their biological taxa – a question about the individual essences of organisms, that can be asked regardless of whether taxa are natural kinds. It is widely thought that organisms belong essentially to their taxa. However, LaPorte (1997; 2004) and Okasha (2002) have argued that organisms belong to their species contingently. Numerically the same organisms could have existed while belonging to a different species, if certain speciation events had been different. In §2.5, I argue that, from the contingency of species membership, it follows that the membership of organisms in higher taxa is also contingent. This thesis was previously defended by LaPorte (1997), but his arguments were incorrect. Here I present a new argument for the contingency of higher taxa membership.

2.3.1. Kripke and Putnam on necessary a posteriori theoretical statements

Beginning in the 1960s, Putnam and Kripke developed a cluster of views concerning natural kinds, natural kind terms, meaning, and necessity, which is broadly known as the Kripke-Putnam thesis, although Ian Hacking (2007) rightly points out that the views of these two authors differ in several ways. In brief, science identifies natural kinds, and provides us with a posteriori necessary truths, i.e., claims which have to be discovered empirically, yet are true in all possible worlds.

Putnam starts by proposing to analyse statements that “look necessary, but that are not analytic”, even though people often take them to be. He calls these sorts of statements “synthetic necessary truths” (Putnam 1962: 659). When discussing Donnellan’s (1962) example “all cats are animals”, Putnam claims that although the statements ‘all cats are animals’ and ‘all bachelors are unmarried’ are both necessary, the first is “less necessary” than the second (Putnam 1962: 660).

While in the case of the meaning of ‘bachelor’ we need only consult a dictionary, in the case of cats we are required to look carefully at what the world is like, because we might be mistaken; they might be, for example, cleverly disguised Martian remote-controlled robots, Putnam argues.

But this, as Kripke observes, is just the distinction between a priori and a posteriori. Since we haven’t in fact discovered that cats are robots, or demons, or anything else – on the contrary, we have confirmed that they are animals – the truth ‘cats are animals’ is, according to Kripke, necessary (1980: 125). It is on a par with, and as necessary as, other scientific truths such as the theoretical identity statements ‘water is H_2O’ and ‘gold is the element with atomic number 79’. It might of course be possible that we are mistaken in any particular discovery, but if we are correct, then those statements are not contingent, but necessary.

Thus, if we came to discover that gold was not in fact yellow, but merely appeared so due to a pervasive optical illusion (Kripke 1980: 118), we should have no inclination to say that we had discovered that this substance was not gold after all; but if we found a substance that resembled gold in all its macroscopic properties, but did not have atomic number 79, we should say it was not gold, but some other substance (as it happens, there is a mineral – pyrite – which has many of the same properties of gold, but is not gold). According to Kripke, natural kind terms such as ‘gold’ function as rigid designators, in the same way as proper names. Once it has been established empirically that gold is a chemical element which has 79 protons in its nucleus, the term ‘gold’ thereafter rigidly refers to any samples of the chemical element with atomic number 79, and does so in all possible worlds.

Something similar is true of biological species; the name ‘tiger’ (or, more scientifically, *Panthera tigris*) does not designate a description or a cluster of properties; it rigidly designates a species. Although tigers have many properties (e.g. black and yellow stripes, four legs, large canine teeth, etc), any of these properties are such that any particular tiger might lack them. For instance, there might be three-legged tigers, and there are rare tigers born without stripes; not to mention tigers that die during development, before they had acquired the relevant features (Hughes 2004: 48, n. 71). And, in fact, even if a particular morphological or genetic property was actually possessed by all, and only, the members of a species, it would still not be necessary – the property could at any moment be lost through random mutation, for example (Okasha 2002). It could even be lost in all members of the species, if the new mutation became fixed. In that case, we would simply have to update our descriptions of tigers. In contrast, there is something “qualitatively different”, Putnam claims, about the feature ‘animal’; it would be much harder to revise the statement ‘all tigers are animals’ (Putnam 1975: 188-189).

It is not impossible to imagine a situation where we might find out that what we thought were tigers were robots after all (Putnam 1975), or that what we took for cats were actually demons (Kripke 1980), but this would not be a situation in which tigers were robots, or cats were demons. It would be a situation in which there were no such things as cats or tigers. Just like pyrite looks like gold, but is not gold, and is known as ‘fool’s gold’, if Kripke’s ‘demon cats’ existed, they would be ‘fool’s cats’, not actual cats. Kripke concludes: “given that cats are in fact animals, any cat-like being which is not an animal, in the actual world or in a counterfactual one, is not a cat” (1980: 126). Although this seems plausible enough, I will argue that, counterintuitively, cats could in fact have existed and not have been animals; however, they could not have failed to be organisms.

It is essential, though, that we start by taking a closer look at the claims in question, since “cats are necessarily animals” can be read in three different ways:

(1) $\Box \forall x (Cx \rightarrow Ax)$ [In every possible world, all cats are animals.]

(2) $\forall x \Box (Cx \rightarrow Ax)$ [Every actual object is such that, in every possible world in which it exists, it is either an animal or it is not a cat.]

(3) $\forall x (Cx \rightarrow \Box Ax)$ [Every actual object is such that either it is not a cat, or else it’s an animal in every possible world in which it exists.]

Claim (1) is *de dicto*. It excludes the possibility, in any possible world, of there being a cat which is not an animal, but leaves open the possibility that an actual cat exists in a possible world where it is neither a cat nor an animal. Claim (2) is *de re*, but it too leaves open the possibility that an actual cat exists in a possible world where it is neither a cat nor an animal. Claim (3) is a different *de re* claim, which excludes the possibility of an actual cat being a non-animal in any possible world, but leaves open the possibility of the existence of non-animal cats in other possible worlds.

Although it is not entirely clear which of these claims Kripke means to assert, LaPorte (1997) and Okasha (2002) have formulated their views concerning the necessity or contingency of an organism’s membership of a particular taxon in terms of the essential properties of particular organisms. The thesis of essential membership is best understood as (3). For this reason, here I focus mainly on claim (3), which is also, arguably, the most interesting one. I argue that it is true of a particular actual cat that it can exist in a possible world where it is not an animal.

My argument, however, works equally well against all three claims. In order to refute (1), I need to show that in at least one possible world, there is a cat which is not an animal. In order to refute (3), I need to show that a particular actual cat exists in a possible world where it is not an animal. Adding the further assumption that this particular cat is also a cat in this possible world, this will also suffice to refute claim (2). Therefore, if I can show that there is a possible world in which a particular actual cat exists and is a cat, but is not an animal, I will have succeeded in refuting all three possible readings of ‘cats are necessarily animals’.

2.3.2. The thesis of essential membership

The claim that organisms belong essentially to their taxa is a claim about the individual essences of organisms, and it is entirely separate from the claim that species themselves have essences. The question is the following: given a particular organism, could this very same organism (i.e. numerically the same individual) have existed while not belonging to its species or to some higher taxon that it actually belongs to? LaPorte (1997) characterised the thesis of *essential membership* as follows:

> “If, in any possible world, an organism belongs (or does not belong) to a particular biological taxon, then there is no possible world in which the organism ever fails to belong (or not to belong) to that taxon.” (LaPorte 1997: 99)

This is LaPorte’s second formulation; he first states it in terms of natural kinds, but then suggests this alternative formulation since, as he admits, the thesis of essential membership is equally compatible with the view that biological taxa are natural kinds (his own view), or individuals, with the slight caveat that in the latter case, the organisms are *parts*, rather than *members*, of their taxa. Having argued at length in chapter 1 that biological taxa should not be considered natural kinds, I evidently prefer to adopt this more neutral formulation; nevertheless, this formulation is compatible with either view on the species individuality debate.

The thesis that particular organisms are such that they could not have belonged to a different species and higher taxa is an entirely separate claim from the fact that organisms belong to the species and higher taxa they in fact belong to in virtue of relational, and not intrinsic, properties. As Okasha (2002: 205) points out, the latter does not immediately refute the former; in fact, some *de re* essentialist claims, such as the necessity of origin, i.e. the claim that an individual organism has its biological antecedents essentially, are also relational.

In fact, LaPorte argues, even if biological species had internal essences, it would still not follow that individual members of those species would belong to them essentially (1997: 97), unless it was impossible for a particular organism to exist in a possible world and yet lack that property. But, here, the possibility that something might exist while lacking the internal (generally presumed to be microstructural) properties that make it the kind of thing it is runs against deep-seated intuitions. However, since species are *not* defined by intrinsic properties of any kind, whether or not it is possible for a particular organism to have existed while having different intrinsic properties is entirely beside the point (Okasha 2002: 207). What matters is whether it could have lacked the extrinsic properties which actually make it part of a particular biological taxon. And it could indeed have lacked those.

In what follows, I argue that true a posteriori theoretical statements concerning biological taxa, such as ‘cats are animals’, are in fact not necessary. Additional detail concerning phylogenetic classification is provided in appendix 1.

2.4. The contingency of species membership

It is natural to think that organisms belong essentially to the species they actually belong to. Again, this question should not be confused with the question of whether or not species themselves have essences. Species might have essences – possibly relational ones, as suggested by Okasha (2002) – or they might not. Either way, the question is the following: given a particular organism, does it belong essentially to the species it actually belongs to? In other words, could numerically the same organism have existed without belonging to this particular species? It is intuitive to think that organisms belong essentially to their species, but there are several arguments against it.

For instance, Hull (1978), applying the biological species concept (based on capacity to interbreed), argues that an organism with a different origin – even, hypothetically, an artificial origin – that somehow turned out to be reproductively compatible with an existing species might, if it proceeded to mate with members of that species, *become* part of that species. This means that an organism might change species, even “while remaining numerically the same individual” (Hull 1978: 350). However, this falls short of claiming that the organism could have existed in the first place without belonging to the species it originally belonged to.

The existence of ring-species, such as the *Ensatina* salamander species complex, also speaks against the necessity of species membership. In these cases, organisms belonging to a population A can interbreed with organisms from population B, B with C, and C with D, but populations A and D can no longer interbreed. In these examples of incomplete speciation, or speciation-in-progress, it might be indeterminate to which species a particular individual in an in-between population belongs to, since the species are not entirely separate yet.

The contingency of species membership applies not only to the biological species concept, but also to evolutionary and phylogenetic species concepts. As LaPorte (1997) argues, an organism which belongs to a given species in the actual world might exist in a possible world in which that species had undergone speciation at an earlier time, and that individual organism might have found itself on either side of the divide. Although this analysis assumes that species go out of existence when they split, which might be debatable, LaPorte suggests that the contingency of species membership might apply to any historically-defined species concept (1997: 106).

In fact, the contingency of species membership is true of phylogenetic and evolutionary species concepts, whether or not they follow Hennig's rule that a species goes out of existence upon speciation. The reason is that evolutionary and phylogenetic species concepts, which apply to species over time, are dependent on non-historical species concepts (e.g. the biological species concept) for the delimitation of speciation events (Okasha 2002). The delimitation of speciation events is crucial for phylogenetics because it is the formation of new species that generates new clades. Since under all accepted non-historical species concepts, the properties that determine whether or not an organism belongs to a given species are not intrinsic to the organisms themselves, it is possible that, if a speciation event had occurred sometime earlier, an organism might find itself on one or the other of the reproductively isolated branches. Thus, organisms do not essentially belong to their biological species (Okasha 2002: 206).

There are good reasons, then, to accept that organisms do not belong essentially to their species. However, it may not immediately seem to follow that they do not belong essentially to their higher taxa – after all, the process of speciation takes place at the species level, not at the level of higher taxa. However, the process of cladogenesis is intimately associated with the process of speciation, which has consequences for the necessity of higher taxa membership, as argued in the next section.

2.5. The contingency of higher taxa membership

As seen above, LaPorte has put forward some convincing arguments for the contingency of species membership. However, regarding the membership of organisms in higher taxa, he has defended two opposing positions: contingency (1997) and necessity (2004). Unfortunately, both of his arguments are flawed.

2.5.1. LaPorte's arguments for contingency

In his 1997 paper, LaPorte argues not only against the notion that organisms belong essentially to their species, but also against their essential membership in higher taxa (i.e. all taxa above the species level). For example, are individual mammals such that they are mammals in all possible worlds? LaPorte replies in the negative. However, although his conclusion is correct, his particular argument in this paper is flawed. In the following discussion I focus exclusively on phylogenetic systematics.

LaPorte's example featuring the clade Aves (birds) is as follows (1997: 109-110). Suppose that a certain species of *Archaeopteryx*, let's call it *Archaeopteryx* sp. A, is the stem species of clade Aves in the actual world. Possibly, *Archaeopteryx* sp. A could have budded forth 'a non-bird taxon' at a time before the branching of the actual first bird branch. Suppose, furthermore, that this branch led to a taxon 'having the same number of organisms, variation, and rank as the Aves', but composed of salamander-like creatures. In that case, those organisms that exist prior to the non-bird offshoot (which I am assuming are still members of the species *Archaeopteryx* sp. A, since the speciation event happens later) would fail to count as birds. So, LaPorte concludes, "it is a contingent matter that any individual member of the relevant *Archaeopteryx* species is a bird" (1997: 109).

Although it is indeed a contingent fact whether or not any individual member of the relevant *Archaeopteryx* species is a bird (I assume that 'bird' means a member of the clade 'Aves'), the analysis is incorrect. Two things are misleading in this description: first, whether the additional branch is a 'non-bird' taxon remains to be seen, and must not be assumed; and second, we cannot suppose the additional branch to have "the same rank as the Aves" (LaPorte 1997: 109), since a sub-clade of a larger clade cannot, ipso facto, have the same rank as the higher clade it belongs to.

Let us continue to assume that *Archaeopteryx* sp. A designates the stem species of Aves in the actual world. Remember that in phylogenetics a clade is defined as a stem species plus all of its descendants. So, Aves = *Archaeopteryx* sp. A + all of its descendants. In the possible world suggested in LaPorte's example, the descendants of *Archaeopteryx* sp. A include not only all the species that comprise Aves in the actual world, but also an additional clade composed of salamander-like species (Fig. 1). Be that as it may, *Archaeopteryx* sp. A is still the stem-species of the clade; so, the clade is numerically the same clade, although it includes many more species. It does not matter whether those additional species are bird-like or salamander-like. Since they are all descendants of the stem species of the clade, in this possible world we are considering, they all belong to the clade Aves.

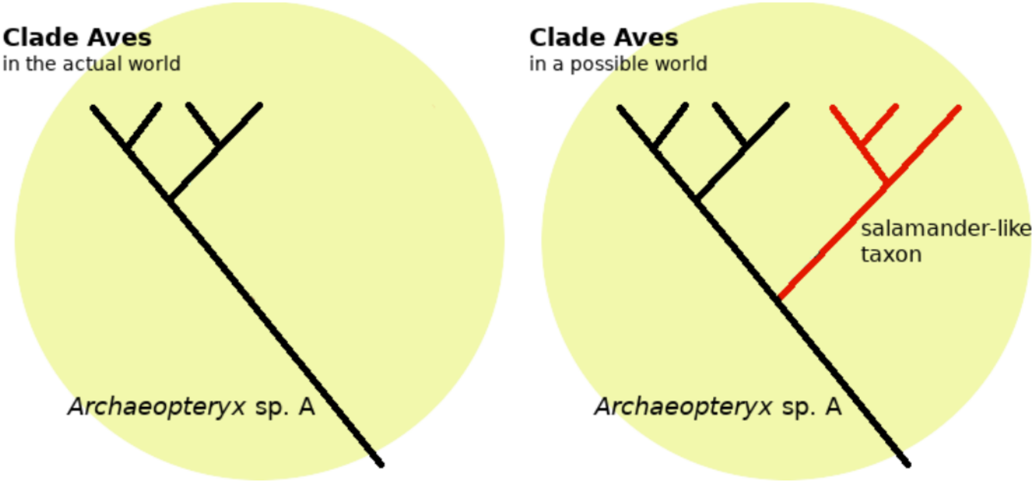

Figure 1. Simplified phylogenetic tree representing the clade Aves in the actual world and in the possible world described by LaPorte (1997). *Archaeopteryx* sp. A is here assumed to be the stem species of the clade Aves for illustrative purposes.

Phylogenetic systematics might seem counterintuitive for this reason: it does not attempt to group organisms that are most similar; the point is simply to capture genealogy. So, for example, the clade Aves is included in the clade Dinosauria, because the clade Dinosauria, like all other monophyletic clades, is defined as the stem species plus all of its descendants – and some of those descendants include the birds. Indeed, birds are a sub-clade of the dinosaurs. For this reason, biologists often refer to 'non-avian dinosaurs' when they mean to refer to dinosaurs excluding birds.

Another example discussed by LaPorte is the case of fish. LaPorte argues that "individual salmon, lungfishes, coelacanths, etc. fail to belong to a common, exclusive taxon", because the taxon 'Pisces' is non-existent (1997: 110). He is quite correct that there is no exclusive taxon 'Pisces' to which only fishes, and no other organisms, belong. But he argues that this is an accident, due to the coming into existence of non-fish descendants of fish, namely the tetrapods, and concludes that fish do not belong to 'a fish taxon', but they could have; so their membership of a higher taxon is contingent. However, as should be clear by now, this argument suffers from a similar problem to the one regarding birds. There *is* in fact a taxon that all fish belong to. It just so happens that this taxon *also includes* all the tetrapods (it is the clade Vertebrata). And this clade is, furthermore, *the same clade* that all the fish would belong to in a possible world in which the tetrapods never evolved. The reason for this is, again, that what defines the clade is not how many remarkably different groups of organisms have evolved within it, but simply that it is composed of a certain stem species plus all of its descendants.

In conclusion, LaPorte's (1997) arguments are incorrect and cannot be used to support the thesis of the contingency of taxon membership. Perhaps for this reason, in 2004, LaPorte argued for the opposite thesis, i.e. the necessity of higher taxa membership under a phylogenetic framework, whilst maintaining his original thesis about the contingency of species membership.

2.5.2. LaPorte's arguments for necessity

In 2004, although maintaining his earlier view that organisms are not essentially members of their species, LaPorte now argues that they are nevertheless essentially members of the higher taxa they belong to. In part, this move certainly seems to reflect a more accurate understanding of phylogenetics. He argues that, according to phylogenetics, a higher taxon such as Mammalia designates "the clade whose members in any possible world are members of the ancestral group *G* or descendants thereof" (2004: 51).

The reason he concludes this is because the theoretical statement that 'Mammalia = the clade that stems from the ancestral group *G*' is necessarily true. LaPorte argues that there is no possible world in which an organism belonging to a mammal species, such as *Panthera tigris*, descends from Mammalia's stem group *G* and yet fails to be a mammal. He claims that the only way a member of *P. tigris* could fail to be a mammal is if it did not descend from *G*, but, since the members of *P. tigris* did descend from *G* in the actual world, there is no possible world in which a member of this species does not descend from *G* (2004: 51).

There is, however, one other possibility: individual members of a mammal species, such as *Panthera tigris*, could have failed to be mammals if they were to exist in a possible world where the clade Mammalia does not exist at all. In the next section, I argue that this is indeed possible; in fact, it follows from the contingency of species membership.

2.5.3. A novel argument for the contingency of higher taxa membership

Let us return to LaPorte's example from §2.5.2. Although LaPorte talks about 'group *G*', the standard understanding in biology is that clades are composed of a particular *stem species* and all of its descendants, and it is the speciation process itself that gives rise to new clades (Wiley & Lieberman 2011). In fact, LaPorte names his 'group *G*' by comparison with Hennig's example of a certain *Archaeopteryx* species as the stem of Aves. But, if individual organisms do not belong essentially to their species, then this no doubt applies to all organisms, including those that belong to the stem species of the clade under consideration. So, it is possible that the individual organisms that were actually the ancestors of the clade Mammalia might have belonged to a different species.

Consider a particular cat, called Josephine, that exists in the actual world. In the actual world, Josephine is a cat, a mammal, and an animal. Now suppose that in the actual world, the stem species of Mammalia is 'therapsid X'. This species originated in a speciation event in which a previously existing species, 'therapsid A' (for 'ancestral therapsid'), speciated into two species: 'therapsid X' and 'therapsid Y'. Each of these later gave rise to other species, and thereby became the stem species of new clades. 'Therapsid X' became the stem species of Mammalia, and 'therapsid Y' the stem species of some other clade. Now imagine that in a possible world, 'therapsid A' did not speciate; in that world, the species 'therapsid X' and 'therapsid Y' never came to be. Nevertheless, 'therapsid A' continued to evolve, and the set of all its members came to include (some of) the very same organisms that in the actual world belong to the species 'therapsid X'. The descendants of 'therapsid A' eventually evolve into all the animals we know as mammals.

Since clades are understood in phylogenetics as being composed of a particular stem species and all of its descendants, it is reasonable to assume that if a certain clade *x* has stem species *y*, then in a possible world in which *y* does not exist, clade *x* does not exist either. Therefore, it is not the case that, in the possible world we are considering, the stem species of Mammalia is 'therapsid A' instead of 'therapsid X'. Rather, since in this possible world 'therapsid X' does not exist, neither does the clade Mammalia. The clade immediately above it, which has as its stem species 'therapsid A' exists in both worlds, but the clade Mammalia does not exist in the possible world we are considering.

Yet this does not entail that particular organisms which in the actual world belong to the clade Mammalia would not exist in that possible world. In order to maintain that numerically the same organism, Josephine, exists in this possible world, I will assume the truth of Kripke's (1980) thesis of the necessity of origin.[39] If the existence of an organism's actual ancestors is necessary for its existence, then all possible worlds where the organism exists also necessarily contain its ancestors. This might lead us to think that an organism's place in a lineage is essential to it (LaPorte 1997): evidently, if an organism has its origin in its immediate ancestors necessarily, then that is equally true of its ancestors, which makes the entire lineage, all the way since the beginning of life, necessary for a particular organism's existence.

But, if organisms do not belong essentially to their species, the existence of an organism's actual ancestors does not require their membership in particular species, or even the existence of those species; rather, what is necessary is the existence of its actual individual ancestor organisms. If organisms are not essentially members of their species, then, for any of an organism's individual ancestor organisms, it is possible that they might have existed and yet belonged to different species. Indeed, in the possible world we are considering, all the actual organisms that are Josephine's ancestors exist; the only difference is that some of them belong to different species than in the actual world. Some organisms which belong to species 'therapsid X' in the actual world would belong to species 'therapsid A' in this possible world, while being numerically the same organisms. And this is indeed possible if species membership is contingent. Therefore, Josephine can exist in a possible world where she is not a mammal, because the clade Mammalia does not exist in that possible world.

If it is possible for an organism which belongs to the clade Mammalia to exist in a possible world in which the clade itself does not exist, then the membership of individual organisms in higher clades is also contingent. Its non-necessity stems from the non-necessity of species membership. LaPorte's (2004) middle-ground position, that one can simultaneously defend the contingency of species membership but the necessity of higher taxa membership, turns out to be inconsistent.

If the above argument is correct, then it follows that, although it is a true theoretical statement that cats are mammals, it is not a necessary statement. Cats are not necessarily mammals. They are not necessarily animals either, since the Kingdom Animalia is another clade, composed of a particular stem species and all its descendants. So, exactly the same argument can be applied to it. And the same can be said of all other organisms and the higher taxa they belong to.

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[39] Note that the existence of an organism's ancestors in a possible world does not guarantee the organism's existence in that possible world; rather, the existence of its ancestors makes its existence possible. In other words: assuming the truth of the necessity of origin, the set of possible worlds where the organism in question exists is a subset of all possible worlds where its ancestors exist.

Yet Putnam and Kripke were not entirely wrong in their assertions. There are no possible worlds in which cats are demons, or tigers are robots. But we can express this modal intuition by claiming that cats and tigers are essentially organisms. Unlike ‘Mammalia’ or ‘Animalia’, which are the names of clades, ‘organism’ does not correspond to a biological taxon. ‘Organism’ is understood in biology as referring to any living entity, regardless of taxonomy. If life exists elsewhere in the universe, as is generally assumed in astrobiology, then ‘organism’ can apply to any material object that exists anywhere in the universe, provided it satisfies the condition ‘being alive’. As such, it functions in the same way as other natural kind terms such as ‘water’ and ‘gold’, which are defined by intrinsic properties. In fact, if we replace ‘animal’ in Putnam’s and Kripke’s statements with ‘organism’, the problem disappears. Both ‘all cats are organisms’ and ‘all tigers are organisms’ are indeed necessary statements; there is no possible world in which cats or tigers exist but are not organisms.

2.5.4. Some objections

One possible objection to the above argument is that, by accepting that an individual mammal organism might have existed without being a mammal, which is equivalent to saying that the same organism exists in a possible world where it is not a mammal, it might seem that we lose our purchase on the transworld identity of the organism. How can we know that we are identifying numerically the same individual organism in a possible world in which it is not a mammal? Unless we accept the possibility of ‘bare identities’ or haecceities, there must be *some* properties which ground the transworld identity of individual entities (Mackie & Jago 2017). It is appealing to think of ‘animal’, ‘mammal’, or even the species an organism belongs to as its substance sortal, which would provide a candidate essential property on which to ground its identity across possible worlds. But it would certainly be question-begging to do so when the question of whether or not organisms belong essentially to their species and higher taxa is exactly what is under dispute. On the assumption that we are following a scientific understanding of what phylogenetic groups are, it cannot simply be assumed that they are substance sortals.

Furthermore, it is not clear that sortals are a good way to ground the identity of particular entities across possible worlds, since, even if belonging to a particular sortal were an essential property of the entity, that property would not, by itself, distinguish the individual entity from all other entities which belong to the same sortal; rather, what is needed is some *exclusive* essential property. More precisely, belonging to a sortal is never sufficient to ground the identity of a particular entity across possible worlds. It may be *necessary* for particular entities to belong to certain substance sortals – this is the view known as sortal essentialism. But even if sortal essentialism is true, biological taxa cannot be assumed to be good candidate sortals, precisely because membership in them is, arguably, contingent. In the previous section, I suggested that individual organisms are essentially organisms. It is possible that the identity of individual organisms across possible worlds is grounded on their belonging to the substance sortal 'organism' together with details about their origin. What sortals cannot do is ground the transworld identity of individual entities in the absence of further, exclusive properties (whether these are qualitative properties or haecceities).

Two other objections come from phylogenetic systematics itself, and both involve a rejection of the requirement that clades be defined by their stem species. The first is the suggestion that, instead of clades being defined by their stem species, they could be defined by the actual organisms that existed at the time of the speciation event that initiated cladogenesis. However, this will not work, for two reasons: one is that, except in highly unusual circumstances (e.g. formation of new plant species by hybridisation, which can happen in a single reproductive event), speciation is a very long process that goes on for generations, so it is hard to pinpoint which would be the relevant organisms. On the other hand, requiring the existence of all the actual organisms that existed between two speciation events seems overly demanding, especially since it is conceivable that a certain clade might have come into existence slightly earlier or slightly later, if the relevant speciation event had been completed slightly earlier or later than was actually the case. So, for instance, although the clade Mammalia necessarily had to originate from its actual stem species, this species might have included numerically different organisms. All this would mean is that numerically different individual mammals would exist today.

The second, and more significant, objection from phylogenetics is that there are alternative ways of naming clades – what phylogeneticists often call 'defining the names of clades' – which are not based on the stem species of the clade. Although all phylogeneticists agree that clades are composed of an ancestral species and all, and only, its descendants,[40] in phylogenetic nomenclature there are two alternative ways of defining the names of clades, in addition to stem-based definitions: *node-based* definitions, and *apomorphy-based* definitions. The former defines the name of a clade

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[40] Both traditional phylogeneticists who follow the Linnaean system and proponents of the alternative system of phylogenetic nomenclature seem to agree on this point. For example, de Queiroz clearly states that clades designated by either of the definitions accepted in the PhyloCode are "defined as parts of phylogeny each of which is composed of an ancestor and all of its descendants" (de Queiroz 2007: 957).

stemming from the most recent common ancestor of two (usually extant) specified organisms, species, or clades, and the latter defines the name of a clade stemming from the first ancestor species to evolve a specified character (de Queiroz & Gauthier 1994: 29).

Consider node-based definitions. For example, consider an alternative, node-based definition of Mammalia as "the clade originating in the most recent common ancestor of *Ornithorhynchus anatinus* (the duck-billed platypus) and *Elephas maximus* (the Asian elephant)". There are two possible ways of reading this definition: (1) on a *de re* reading, the definition simply fixes the reference on a particular stem species. Because we are not directly acquainted with the stem species, we refer to it indirectly as 'the (actual) species which was the most recent common ancestor of the platypus and the elephant'. The reference to the ancestral species is fixed; the clade is still defined as a particular ancestral species plus all, and only, its descendants. If we interpret the definition in this way, we can maintain that, had the actual ancestral species not existed, the clade would not have existed either.

Alternatively, we can interpret the definition as *de dicto*. In this case, the reference is to the most recent common ancestor of the platypus and the elephant, *whichever it is*. On this reading, the identity of the stem species of the clade is not considered essential to the existence of the clade itself. In this case, the clade is *defined* by reference to the two extant species (the *specifiers*), rather than the stem species of the clade. So on this interpretation, it would be possible for the same clade to exist while having a different stem species, and the example in §2.5.3 fails. But if a clade were to be defined in this way, then all we would have to do would be to postulate a possible world in which at least one of the specifiers did not exist; that would be a possible world in which the clade did not exist either. In fact, this would be even less problematic than postulating hypothetical changes to the stem species, because these possible worlds need not involve any changes whatsoever in the entire lineage leading up to the organism in question. Even in the particular case where the individual organism happens to belong to one of the specifiers of the clade, there are possible worlds where it exists but the *other* specifier of the clade does not, and, therefore, the clade does not exist either. So, on this interpretation, too, there are possible worlds where a particular cat exists but is not an animal, because the clade Animalia does not exist in that possible world.

Apomorphy-based definitions are less preferred in phylogenetic taxonomy,[41] but can be dealt with in a similar way. Either they simply fix the reference of the stem species, and the argument in §2.5.3 goes through unscathed; or they refer *de dicto* to whichever species first evolved a particular apomorphy, in which case we can postulate a possible world in which a different

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[41] Especially for crown clades. See article 9.9 of the PhyloCode (Cantino & de Queiroz 2020).

species first evolved the character in question.

2.6. Reformulating Animalism

Although not accepted by all animalists, the claim that we are essentially animals is a far more interesting claim that the simple claim that we are animals. In this chapter, however, I have shown that all actual animals are animals contingently: we do not belong either to the species *Homo sapiens* or to the Animal Kingdom essentially. Therefore the strong animalist claim that we are essentially animals must be abandoned. This does not mean rejecting animalism, since it is possible to maintain that we are animals contingently. But if animalism is formulated as the view that we are *organisms*, then it is possible to maintain the strong animalist claim that we are essentially organisms.

‘Organism’ is one of the most fundamental natural kinds in biology. It is a kind widely held to be defined by intrinsic essential properties. Here I agree with Dumsday (2012), who says that ‘organism’ is “a clear example in biology of a highly generic kind defined wholly in terms of intrinsic properties” (490). Tuomas Tahko (2022) also states that, on Lowe’s view, a cat falls under “the general kind of *living organism*”, which is characterised by a general essence. Namely, organisms are characterised by the essential property ‘life’. They are living entities. “Organisms differ from other material beings by having *lives*” (Olson 2007: 28). As Olson (2021) points out, life “does not simply occur here and there, like wind or gravity”; rather, it comes in discrete packages or units – “[f]or there to be life is for there to be living things” (63). Although there are other biological units, organisms are the only *living* ones.[42]

The formulation of animalism as the claim that we are organisms has been explicitly put forward by some animalists, most notably van Inwagen (1990), Liao (2006, 2010), and, more recently, Steven Luper (2022). Other animalists treat ‘human animal’, ‘animal’, and ‘organism’ as alternative hypotheses for what our substance kind might be, but seem not to be excessively worried about which one exactly turns out to be true. Thus, Snowdon (1991) – having come across the worry that ‘organism’ might be preferable to ‘animal’ (on the basis of what seems to me to be a mistaken interpretation of animal development) – concludes that:

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[42] Chapter 3 discusses life and the nature of organisms.

> “this leaves us with the problem of hitting on the right basic natural category in terms of which to state the thesis. Having noted the problem, however, I shall stick with animal, since, in considering the argument I am interested in, it does not matter which precise natural category we choose” (Snowdon 1991: 111)

On the contrary, I have argued that it does matter which category we choose. Animalists need to be more precise in stating the kind we belong to, because neither ‘animal’ nor ‘human animal’ are appropriate options.

Nevertheless, animalists who defend the view that we are animals, or, more specifically, human animals, need make no more than a mild adjustment to their claims, since in fact they already presuppose than human animals are animals and that animals are organisms. Olson (2007), for instance, states that “animals are biological organisms, along with plants, bacteria, protists, and fungi”, and therefore “animals, including human animals, have more or less the same metaphysical nature as other biological organisms” (27); Bailey (2017) claims that “[a]ccording to animalists, human persons are organisms” (2315); likewise, Lim (2019) accepts the assumption that “according to the standard animalist, animals are biological organisms” (384, n. 3).

This reformulation does have some consequences, however. Most animalists understand the view as telling us something about our fundamental nature: “[i]f animalism is correct, then our fundamental nature is indistinguishable from that of blue whales, myna birds, bonobo chimpanzees, and ring-tailed lemurs” (Blatti 2020). Whereas if personalism were correct and our nature was such that we would survive a cerebrum transplant, then “the metaphysical nature of human animals would not follow from their being animals; they would have a fundamentally different nature from other animals, or at least from some other animals: oysters, for instance” (Olson 2015a: 102-103). If, however, we are essentially organisms, yet only contingently animals, and if ‘organism’ is a persistence kind, then it seems that our persistence conditions are instead the persistence conditions of organisms. In chapter 3, I address the question of what organisms are, and, in subsequent chapters, I discuss organismal persistence.

2.7. Conclusion

Biological taxa (including species and higher taxa) are either not natural kinds at all or, if they are natural kinds, they are defined exclusively by relational properties. Furthermore, organisms do not belong essentially to their taxa, only contingently. Therefore, biological taxa such as the species *Homo sapiens* and the animal kingdom are inadequate answers to the question ‘What kind of thing are we?’. Strong animalism can still be maintained, however, if formulated as the claim that we are essentially organisms.

CHAPTER 3

Life and Living Beings

This chapter addresses the question of what life is and develops a new metaphysical account of organisms, based on a naturalistic answer to the special composition question. §3.1 discusses what life is, the problems with defining life, and introduces the distinction between the life of an organism and life as a historical-collective phenomenon. §3.2 presents a new account of the metaphysical nature of organisms, the living objects view, which argues that organisms are living material objects, and is based on a naturalistic approach to composition, namely the bound state view. §3.3 is a brief conclusion.

Sections §3.2.1 – 3.2.4 of this chapter result from work developed in collaboration with James Ladyman, and appear with slight changes in the following manuscript: Hermida, M., & Ladyman, J. (2022). Living Objects [preprint]. http://philsci-archive.pitt.edu/id/eprint/21430.

CRediT author statement: Margarida Hermida: Conceptualisation; Writing – Original Draft; Writing – Review & Editing. James Ladyman: Conceptualisation; Writing – Review & Editing; Supervision.

3.1. What is life?

Life is a fascinating phenomenon, but not an easy one to define. Definitions of life tend to highlight one or more of the following features: metabolism, organisation, reproduction, autonomy, and occasionally teleology. It is clear that life is not a particular kind of matter; living things are made from the same physical stuff as everything else. Rather, "living systems have special properties which arise primarily not from the substances of the system, but from their special organisational manner" (Gánti 1975). Fred Feldman (1992) refers to life as "a property of certain complex material objects" (112); this property is shared by all living things; the lives of particular entities, however, are events. Van Inwagen (1990) also refers to lives as "self-maintaining events" (87).

Life is a process that maintains certain material objects (living organisms) in a dynamic equilibrium. There are two kinds of stability: objects that are thermodynamically stable, like rocks, tend to remain mostly unchanged for long periods of time in the absence of disturbance; rivers and waterfalls, on the other hand, are examples of *dynamic stability*, which requires a continuous input of energy to maintain the dynamic structure (Pross 2012). From a chemical perspective, biological systems have a special kind of dynamic stability, *dynamic kinetic stability*, which is related to the property of replication in chemical systems (Pross 2012). Organisms maintain their dynamic stability using energy they harness from their environment.

Despite our increasing knowledge of the functioning of molecular constituents of the cell, we are still far from having a complete understanding of what life is. We lack a universal theory of life, not only because we have only one example, Earth life (Cleland 2019: 105-131), but also because we do not fully understand the principles that allow the highly organised, complex, dynamic, and far-from-equilibrium chemical systems that constitute life to emerge from abiotic chemistry (Pross 2012: 100). Nevertheless, many scientists and philosophers have tried to define life. Luisi (1998: 617) lists some of the criteria that a good definition of life should satisfy: it should permit us to discriminate living from non-living things in an operationally simple way; it should not be too restrictive; all forms of life that we know about should be covered by the definition; it should help to design experiments in synthetic biology and help astrobiologists decide whether putative biological forms are alive; and it should be logically self-consistent.

Erwin Schrödinger (1944) considered life to be "orderly and lawful behaviour of matter, not based exclusively on its tendency to go over from order to disorder, but based partly on existing order that is kept up" (69). He suggested that a piece of matter can be said to be alive "when it goes on 'doing something', moving, exchanging material with its environment, and so forth, and that for a much longer period that we would expect an inanimate piece of matter to 'keep going' under similar circumstances" (70). When a non-living piece of matter is left alone, it goes into thermodynamical equilibrium very quickly; whereas a living piece of matter goes on 'doing something', evading thermodynamic equilibrium for a longer period of time, due to its own efforts. The way it achieves this is through metabolism: "How does the living organism avoid decay? (…) By eating, drinking, breathing and (in the case of plants) assimilating. The technical term is metabolism" (Schrödinger 1944: 71). Through metabolism, "the organism succeeds in freeing itself from all the entropy it cannot help producing while alive" (72). For a while, at least.

Some astrobiologists also highlight thermodynamic disequilibrium and the importance of metabolism. For example, Dirk Schulze-Makuch and Louis Irwin (2006) consider life to have three main characteristics:

> "life is (1) composed of bounded microenvironments in thermodynamic disequilibrium with their external environment; (2) capable of transforming energy and the environment to maintain a low-entropy state, and (3) capable of information encoding and transmission" (Schulze-Makuch and Irwin 2006: 14).

NASA's working definition is that "life is a self-sustained chemical system capable of undergoing Darwinian evolution" (Joyce 1994).[43] Darwinian evolution "subsumes the processes of self-reproduction, material continuity over an historical lineage, genetic variation, and natural selection", while the requirement that the system should be self-sustained does not imply its independence from the environment, but merely "refers to the fact that living systems contain all the genetic information necessary for their own constant production (i.e., metabolism)" (Joyce 1994: xi).

Although simple and prima facie quite promising, this definition is at once too broad and too restrictive. It is too broad because Darwinian evolution is a powerful mechanism that can apply to many things; it only requires a population of things that vary among themselves, that can somehow produce things similar to themselves, and that the 'offspring' entities tend to resemble the 'parental' entities (Lewontin 1970; Godfrey-Smith 2009). Besides organisms, other things, including non-living ones, can form Darwinian populations and undergo evolution by natural selection, as long as they fulfil these requirements (Godfrey-Smith 2009). Genes and biological species have been suggested as units of selection, and neither are alive. Natural selection can even occur among RNA molecules in a test tube; due to chemical kinetics, any faster-replicating molecules out-compete the slower-replicating ones (Pross 2012: 78-79). The Darwinian definition of life seems to imply that the RNA molecules in the test tube are alive; yet that does not seem correct. On the other hand, the definition is too restrictive, because it can only apply to populations of things, excluding single specimens from consideration (Luisi 1998), since only populations, not individual organisms, evolve (see §3.1.2).

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[43] As Luisi points out (1998: 617), it is implicit in this definition that the chemical system is powered by an external source of energy, in accordance with the second law of thermodynamics.

3.1.1. Problems with defining life

Researchers involved in attempts to define life assume that they are engaged in a worthwhile project. Some authors, however, question our ability to define life at this stage of our scientific understanding of the phenomenon, as well as the usefulness of doing so (Cleland & Chyba 2002; Cleland 2012; Machery 2012). Carol Cleland (2012), for instance, argues that what is needed is not a definition, but a theory of life, and that we are not, at the moment, able to formulate an adequate theory. We are in a situation comparable to that of a seventeenth-century scientist trying to define ‘water’, who, prior to the development of molecular theory, would have been limited to enumerating the sensible properties of water, while being unable to reach any deeper understanding of it (Cleland & Chyba 2002; Cleland 2012). At the moment, “[w]e just don’t know enough about life as a general phenomenon to formulate scientifically fruitful identity statements about it” (Cleland 2012: 128).

One of the problems facing attempts at defining life is the limitation of having only one example, also known as the N=1 problem. Empirical evidence strongly points to all extant life on Earth sharing a common ancestor. Because of this, “familiar Earth life represents a single example”, which may not be representative of life in general, but may instead reflect “chemical and physical contingencies present on the early Earth” (Cleland 2012: 126). Since we have no way of knowing which features of Earth life are essential to all life and which are peculiar features of how life evolved on this particular planet, the argument goes, we should abandon attempts to define life. Instead, astrobiologists should focus their research on interesting ‘anomalies’, i.e., “physical systems resembling familiar Earth life in provocative ways and yet also differing from it in important and unanticipated ways” (Cleland 2012: 141). On Cleland’s view, premature definitions of life based exclusively on Earth life could impair efforts to find truly alien life forms, by inhibiting research into anything that does not comply with the chosen definition.

While Cleland is correct in highlighting the main difficulty – the fact that we are restricted to a single example, life on Earth, the claim that this example may not be representative can be disputed. Charles Cockell (2016) argues that, far from being the case that alien life “would have forms and structures unlike anything we can imagine” (1553), due to biophysical and biochemical constraints, life in the universe is likely to be restricted to a limited range of possibilities. It is very likely, in fact, that Earth life is a typical example, which can be used to infer the most probable features of life elsewhere (Lineweaver & Chopra 2012).

For instance, of all the elements of the periodic table, only silicon has been seriously entertained as a possible alternative to carbon as the main building block for life; yet its tendency to form silicates in the presence of oxygen makes it more prone to form inert compounds such as rocks than to participate in the dynamic process of life (Cockell 2016: 1554).[44] At best, silicon might provide an alternative to carbon under "very restricted environmental conditions", including absence of oxygen and water, extreme temperatures, high pressures, presence of methane or methanol, and relative lack of available carbon (Schulze-Makuch & Irwin 2006: 96). Moreover, even if silicon were just as likely as carbon to be used as a basis for life, carbon's higher abundance in the universe would still make carbon-based life forms twenty times as common as silicon-based ones (Lineweaver & Chopra 2012).

The presence of a liquid solvent that permits complex chemistry is a universal requirement for life. While several possible alternatives to water as a solvent have been suggested (e.g. ammonia, hydrocyanic acid, and methanol), none are quite as versatile, or as common in the universe, as water. Water is abundant in the universe, and has a tendency to condense in liquid form on rocky planets, either on or below the surface (Cockell 2016: 1554). Its physical and chemical properties, especially its ability to dissolve both polar and nonpolar compounds, make it ideal as a solvent. Nevertheless, it cannot be ruled out that, on planets where water is not found in the liquid state, other solvents might permit the emergence of life based on very different biochemistry (Schulze-Makuch & Irwin 2006: 101-120).

While the building blocks of life "could have been at least modestly different without compromising their biological functionality" (Cleland 2012: 129) – for instance, the genetic code might have been different; a different set of amino acids might have been used – none of these possibilities involve quite dramatic differences, but instead are variations on the same theme.[45] Likewise, Earth life builds proteins using exclusively homochiral (L) ('left-handed') amino acids, and all carbohydrates and nucleic acids are built from (D) ('right-handed') sugars; whereas abiotic mixtures of amino acids are usually racemic (i.e. contain both L and D elements in similar proportions). Alien life might use a different chirality; however, it is overwhelmingly likely that alien biomolecules would still be homochiral, due to the requirement of inter-compatibility (Lineweaver & Chopra 2012). Ultimately, "biochemistry allows for variety, but at its core, it is constrained by the functions it must perform" as part of a living system (Cockell 2016: 1554).

A feature of Earth life that is certain to be universal is the acquisition of external energy, since this is a requirement for the maintenance of a dynamic system far from thermodynamic

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[44] Although some Earth life forms use it to produce hard structures (e.g. diatoms).

[45] Over 60 different amino acids have been detected in carbonaceous meteorites; Earth life uses only a subset of 20.

equilibrium. On Earth, life acquires energy through the movement of electrons across a chain of electron donors and acceptors. Again, the use of these energy sources is likely to be a universally successful way to acquire energy, and the ubiquitous availability of electrons make this pattern highly likely to be independently evolved by different forms of life (Cockell 2016), though other energy sources might be possible.[46]

Finally, the chemistry of life requires solutes to be kept at concentrations distinct from those of the surrounding environment, which is impossible in the absence of a structure that provides this separation. On the other hand, the living organism needs to absorb substances from the external environment and excrete waste products; this is the very meaning of metabolism. Therefore, a semi-permeable membrane is also a necessary requirement for life (Cockell 2016).

3.1.2. Organisms vs. historical-collective phenomenon of life

The main problem with most definitions of life, in my view, is that the phenomenon of life is not unitary, but consists essentially of two distinct aspects: the individual living organism, and the collective, spatio-temporally extended phenomenon of life in which the organism is embedded. Van Inwagen (1990: 83) complains that Locke does not clearly distinguish between “the count-noun ‘life’ and the mass-term ‘life’”. Similarly, the content of life definitions “can range from life considered as a collective phenomenon – the living world or the biosphere in general – or as the distinctive character of any individual living system” (Bich & Green 2018: 3931). Many definitions try to encompass both, which is why they waver between highlighting metabolism and Darwinian evolution.

‘Life’ is in fact ambiguous: it can mean the life process, which is continuous from an origin of life event all the way to the extinction of all its descendants, and can produce, over time, increasing complexity and diversity; or it can refer to the particular life of each individual organism, which is maintained through metabolism, and may or may not involve replication. It is almost certain that wherever life occurs in the universe, organisms will be part of populations rather than occurring as isolated individuals and, regardless of the particular form of inheritance, phylogenetic trees (or webs) are also likely to be a ubiquitous feature of life (Cockell 2016: 1555). On the other hand, it is equally impossible for any long-term life process not to be individualised into separate organisms, with their own lives.

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[46] For a comprehensive review, see Schulze-Makuch and Irwin (2006: 49-76).

A concern that is often raised about the Darwinian definition of life is that sterile organisms such as mules are not alive according to the definition since, being unable to reproduce, they are presumably not capable of Darwinian evolution (Cleland & Chyba 2002: 389). But surely, individual organisms that do reproduce are not capable of Darwinian evolution either: evolution is not a property of individuals, but of populations (Chodasewicz 2014). And, conversely, neither populations nor lineages can metabolise; that is a property of individual organisms.

Cleland and Chyba (2002) agree that the exclusion of sterile organisms is a problem for the Darwinian definition of life, but argue that "[t]rying to defuse this dilemma by dividing our subject into two categories, 'life' and 'living entities', needs to be explained as more than an ad hoc effort to protect a particular definition" (389). On the contrary, it is precisely because these are in fact two distinct categories that NASA's working definition, while possibly quite adequate for dealing with one (the temporally extended collective phenomenon, which is capable of undergoing Darwinian evolution), cannot at the same time capture the other (the individual organism, which metabolises and thus maintains itself far from thermodynamic equilibrium). Trying to include two distinct things into a single definition, then, is at the root of many problems facing life definitions.

When trying to define life, researchers are persistently led to mix aspects of the living individual organism with aspects of the whole collective phenomenon, even while at some level trying to separate them. Thus, Tibor Gánti (2003: 22-28) divides criteria for life into "real (absolute) life criteria", in which he includes the following: a living system must (i) be an individual unit; (ii) perform metabolism; (iii) be inherently stable, i.e. homeostatic; (iv) have an information carrying subsystem; and (v) regulate and control its own processes; and "potential life criteria", which include growth and multiplication, capacity for hereditary change and evolution, and mortality. Arguably, 'real life criteria' are features of individual organisms, whereas 'potential life criteria' are features of the historical-collective phenomenon of life.[47]

Krzysztof Chodasewicz (2014) notes that "[e]volutionary definitions are collective definitions", and proposes to amend the Darwinian definition of life in a way that makes it specifically applicable to living organisms: "'Life' (a living individual) is a self-sustaining object belonging to a set of elements capable of undergoing Darwinian evolution" (43). Although this definition is similar to Joyce's (1994), it explicitly makes the self-sustaining ability a capacity of individuals, not of the whole system. However, while this definition may apply to all actual living organisms, it is not metaphysically necessary that a living being should be part of set of elements capable of undergoing evolution. When Ruiz-Mirazo et al. (2004) claim that "a living being cannot

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[47] With the possible exception of mortality, which is also a feature of individuals.

exist but in the context of a global network of similar systems” (338), they mean that no living being could *evolve* outside of such a collective network; no living beings will be encountered in nature outside of such a context. But that does not preclude the theoretical possibility of synthesising a single individual organism in the lab.

Nevertheless, Ruiz-Mirazo et al. (2004) are on the right track in establishing a clear distinction between the individual and collective phenomena. The spatio-temporally extended phenomenon of life is characterised by evolution, diversification, increasing complexity, etc; whereas the life of each particular organism is characterised by features such as metabolism, autonomy, and separation between organism and environment. The historical-collective phenomenon, moreover, has “both a synchronic-ecological side”, which includes populations, ecosystems, and perhaps the biosphere, and a “diachronic-evolutionary” one (Ruiz-Mirazo et al. 2004: 338) involving historical lineages and clades – including the very large clade which includes all of life on Earth that descends from a single ancestor (Hermida 2016, 2022). Although we may think of individual organisms – as well as species and higher taxa – as ‘slices’ of the larger ‘historical-collective phenomenon’ of life on Earth, organisms differ from all other entities in having, literally, their own lives: life can only exist when instantiated in individual living beings.

3.2. Organisms are living material objects

‘What is an organism?’ is one of the most important questions in the philosophy of biology. Recently, however, there has been a tendency to focus on the question of *biological individuality,* i.e., ‘what is a biological individual?’, to the detriment of the more specific question of *organismality*, i.e. ‘what is an organism?’. While this development might seem to reflect a greater understanding of the multiplicity of biological phenomena, framing the question in this way has greatly increased confusion. Even more problematically, many authors use ‘organism’ and ‘biological individual’ interchangeably (Clarke 2010, 2013; Olson 2021), even though the two terms do not always co-refer. Thomas Pradeu (2016) argues that ‘biological individual’ is ambiguous between two very different concepts: an *organism*, in the sense of an integrated physiological unit, and an *evolutionary* or *Darwinian individual*, which means ‘unit of selection’, and can designate any entity that is subject to natural selection, e.g., genes, cell lineages, organisms, species, etc.

But the problem is greater than that. Recently, Okasha (2022) has argued that the ‘problem of biological individuality’, as usually formulated, rests on a category mistake. It is not just that there are many kinds of biological individual; the problem is that most of the literature on biological individuality makes the unwarranted assumption that ‘biological individual’ is a sortal, when in fact it is not. This is all the more relevant as much of this literature explicitly appeals to the importance of *counting* biological individuals as one of the motivations for engaging with the problem in the first place. But there is no answer to the question ‘how many biological individuals are there?’ in any specific case, unless *which kind of individual* is specified, or determined by the context (Okasha 2022). Unlike the earlier preoccupation with the individuality of species, most recent discussions of biological individuality are about which entities should be considered organisms, and which ones should not; it is therefore “unfortunate that this issue is so often described as being about biological individuality, rather than organismality” (Okasha 2022). Here I am exclusively concerned with the latter.

Olson (2021) characterises the problem of biological individuality as the question of “how life divides into living things”. This is, in fact, an apt characterisation of the problem of organismality, since, although there may be many different kinds of biological individuals, organisms are the only *living* biological entities. My approach is, thus, diametrically opposed to Ellen Clarke’s, who begins her survey of criteria of biological individuality by *taking the notion of life for granted*: “[t]he problem of biological individuality can be distinguished from the problem of defining living systems by focusing on what properties separate living individuals from living parts and from living groups, while taking the property of life itself for granted” (2010: 316). In contrast, my aim is to define organisms, i.e., the living entities (or ‘living systems’), *regardless* of whether they also happen to be part of other living entities, or have other living entities as parts. The relevant question when trying to ascertain whether something is an organism is precisely ‘is it alive?’, *not* ‘is it a part of something else?’ or ‘is it made up of other living entities?’. The fact that something is either a group of organisms or part of an organism does not, by itself, tell us whether it is a *living* entity in its own right.

In what follows, I provide a new account of what organisms are, based on a naturalistic account of the composition of material objects. I argue that organisms are material objects that instantiate the property life, i.e., they are living material objects.

3.2.1. Physical structure is essential for life

The most conspicuous features of life are its activity and high degree of organisation. Life involves a variety of processes which include metabolism, growth, self-maintenance and repair, reproduction, and evolution. Schrödinger (1944) famously described life as “orderly and lawful behaviour of matter”, considering that “a piece of matter” may be said to be alive when it “goes on ‘doing something’, moving, exchanging material with its environment, and so forth” (70). Living entities can carry out all this activity because they harvest free energy from the environment and use it both to maintain their own highly ordered structure, and to perform work on the environment (Schulze-Makuch & Irwin 2018: 20).

On Earth, metabolic reactions always involve electron transfer, whether the source of energy is light (photosynthesis), non-biological molecules (chemolithotrophy), or biological compounds (chemoorganotrophy) (Schulze-Makuch & Irwin 2018: 8-9). While there are inorganic analogues of these processes, in living entities these reactions are controlled by the organism itself. They also involve a form of “energy budgeting” where organisms harvest free energy from the environment and store it in a convenient molecular form, which can later be converted back into usable energy (Boden 1999: 236-238).[48] Metabolism, understood as the active exchange of energy and matter with the environment, regulated by the organism, involving various anabolic and catabolic chemical reactions which maintain the organism far from thermodynamic equilibrium, is thus a central feature of life.

Organisms are chemically open systems that actively exchange matter with the environment, as well as energy. Inert physical objects, such as rocks, also exchange energy with the environment to some extent, e.g. by heating up and then cooling down; but they do so passively, and they do not exchange matter – although they may lose matter over time through erosion, or gain it through deposition. In contrast, organisms are constantly and selectively exchanging matter with the external environment, incorporating substances that are necessary for their maintenance and repair, and excreting waste products. In doing so, they maintain a lower state of entropy within themselves, exporting the excess entropy to the external environment, as argued by Schrödinger (1944).

All of these exchanges of energy and matter, as well as the maintenance of a lower state of entropy compared to the surrounding environment, require a boundary. One of the main features of living cells is the distinction between the inside and the outside of the cell, a distinction which is maintained by the existence of a physical barrier, the cell membrane. Thus, the cell is a physical object that includes the cell membrane and all the contents located on the inside of this barrier (which may include solid, liquid, and even gaseous components), which are bound by electromagnetic forces to the space inside the cell membrane.

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[48] For Earth life, this is usually ATP (adenosine tri-phosphate), which can be degraded into ADP (adenosine di-phosphate), releasing energy.

The importance of physical boundaries for the existence of life has long been recognised in astrobiology. Schulze-Makuch and Irwin, for instance, consider it a fundamental characteristic of a living thing that it be a “self-sustaining bounded local environment in thermodynamic disequilibrium with its surroundings” (2018: 19). In fact, cell membranes, cell walls, and other similar structures are important in at least four ways:[49]

(1) They contain the organism within a restricted spatial location, preventing its components from being lost (thus making the organism a coherent physical object), and maintaining close proximity between the substances involved in the various chemical reactions necessary for life.
(2) They allow the organism to engage in selective exchange of matter with the environment, not only by having a semi-permeable structure, but also structures dedicated to passive selective transport (such as channel proteins), and even to the active transport of solutes against a concentration gradient, expending energy to do so (such as pump proteins). Therefore:
(3) They allow the organism to maintain a homeostatically controlled environment, where entropy is minimised, on the inside of the barrier.
(4) In addition, membranes (whether the cell membrane itself or, in eukaryotes, mitochondrial and chloroplast membranes) are fundamentally involved in the process of energy acquisition from the environment which, for all life on Earth, involves moving electrons (free electrons or from an electron donor) through a membrane, to an electron acceptor, and simultaneously pumping protons across a membrane to generate the energy used to produce ATP, the energy currency of the cell. While it is conceivable that other forms of life might use different biochemistry, the ubiquity and convenience of electrons as a free energy source suggests that energy acquisition mechanisms based on the movement of electrons across a membrane might be a universal feature of life (Cockell 2016).

In sum, for any entity to be alive it needs to have a boundary that is itself a physical object, and which is strong enough not only to hold itself together, but also to hold all the other necessary components for life on the inside. It must not, however, be completely impermeable, but must allow the organism to engage in selective exchanges of materials with the external environment. The fact that metabolism requires the existence of physical boundaries means that organisms are necessarily

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[49] All cells are surrounded by a cell membrane, which separates the inside of the cell from the external environment. Many bacterial and eukaryotic cells (especially in algae, plants, and fungi) also have a rigid cell wall, which provides structural support and can also function as an additional filtration barrier.

physical objects. The importance of physical structure for living entities is thus a consequence of the requirements of metabolism itself.[50]

Organisms have the impressive capacity to engage in and coordinate their own metabolism, growth, reproduction, and other life processes. But where do these capacities come from? They certainly do not come from a special vital force, or from anything other than garden variety physics and chemistry. These capacities can only come from the physical structure of the organism, some of which is produced by the organism itself, following genetic instructions laid down by evolutionary trial and error, and some of it is directly transmitted from one organism to another during reproduction, and is only maintained, not produced *de novo*, by each individual organism.

Given the importance of physical structure for life, organisms should be considered physical objects and, given the complexity of this structure, they are certainly not simples. Organisms are therefore a particular case of a composite physical object – they are physical objects which have the property 'being alive' or, in other words, living objects. As a consequence, any solution to the problem of organismality will require a naturalistic account of composition, i.e. an answer to the special composition question, which allows us to say what composite objects there are, and which can then be applied to the particular case of organisms, understood as living objects. The next section assesses a recently suggested approach which is particularly promising for this project since it is entirely compatible with a metabolic conception of life.

3.2.2. The bound state answer to the SCQ

The Special Composition Question asks when a plurality of things composes something or, more precisely, "when is it true that ∃*y* the *x*s compose *y*?", where the *x*s refer to two or more things (van Inwagen 1990: 30).[51] Somewhat surprisingly, the most popular philosophical answers are extremely counterintuitive: some philosophers argue that it is never the case that a plurality of things composes something else, i.e., there are only simples – this is the *nihilist* view (defended for

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[50] Although arguing that metabolism is essential for life, Boden (1999) rejects the claim that metabolism must be continuous at all times. Many organisms are able to survive for long periods of time in a state of cryptobiosis, in a frozen or dehydrated state, where their metabolic activity is suspended. Cryptobiosis is discussed in chapter 6.

[51] Where "the *x*s compose *y*" is an abbreviation of the expression "the *x*s are all parts of *y* and no two of the *x*s overlap and every part of *y* overlaps at least one of the *x*s" (van Inwagen 1990: 29). Van Inwagen uses 'the *x*s' as a plural referring expression to avoid talking about pluralities, multiplicities, etc., which sound a lot like entities themselves.

example by Sider 2013); others argue that any random assemblage of things always composes a further object – this is known as *universalism* (defended by Lewis 1986, among others) or, in its more extreme version, *plenitude* (defended for example by Sosa 1987).[52] In between lie so-called ‘moderate’, minimalist, or exceptionalist views, which consider some things as composite objects, but not others. For example, van Inwagen’s (1990) own view about composition is that some things compose a further object when their activities constitute a life (82), whereas Trenton Merricks (2001) argues that persons, and perhaps some other cognitively sophisticated animals, are the only composite objects that exist (114).

Henceforth our concern is with the composition of physical objects. None of these views seems attractive, or even plausible in this context. The main motivation for them is the perceived need for a clear criterion of composition which avoids problems of arbitrariness and vagueness at all costs. In doing so, however, they either eliminate most ordinary and scientific objects, or else admit into the ontology arbitrary sums of bits and pieces of actual objects, such as a ‘*trog’*, a supposed object composed of a dog and a tree trunk (Korman 2015: 2). By comparison, a ‘moderate’ ontology like van Inwagen’s, which accepts the existence of living organisms but no other composite objects, certainly seems like an improvement, but it still fails to account for most of the objects we encounter and manipulate in our daily lives, much less those studied and described by science.

Nihilist, universalist, and the exceptionalist views mentioned above are examples of what Paul Humphreys (2013) disparages as ‘speculative ontology’: ontological landscapes which deliberately ignore the entire scientific enterprise, in favour of a priori assumptions and appeals to intuition. These extreme views have little to recommend them since they make no distinction between the composite objects endorsed by science and imaginary ones for whose existence there is no empirical evidence. For this reason, these accounts have little relevance outside of the ‘ontology room’.

Recently, however, some philosophers (McKenzie & Muller 2017; Husmann & Näger 2018; Waechter & Ladyman 2019) have argued for a naturalistic view of composition based on physical

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[52] Plenitude is even more extreme in its permissiveness as, in addition to objects composed of arbitrary mereological parts, it also admits the existence of objects with extraordinary temporal and modal properties, such as the *incar*, which refers to any part of a car which is essentially inside a garage, and ceases to exist if the car is taken out of the garage (Hirsch 1982: 32); and the *snowdiscall*, “an object made of snow, that has any shape between being round and being disc-shaped, *and* that has the following strange persistence conditions: it can survive taking on all and only shapes in that range” (Korman 2015: 17, from an example due to Sosa 1987: 178).

science: the bound state view.[53] Although the different extant versions of the bound state view are similar in many respects, this discussion is based on Waechter and Ladyman (2019), whose account is more rigorously developed, and deals specifically with questions that are particularly relevant for the case of organisms, such as whether composite objects can themselves compose other composite objects. Waechter and Ladyman (2019) summarise their thesis thus: “in order to compose something at t_0, physical objects must form at t_0 a connected plurality under the relation of forming a bound state” (109).[54] Roughly, a bound state is one in which the kinetic energy of the parts is less than their potential energy.[55] More precisely, the bound state view of composition can be stated as follows:

The *xs* compose *y* at t_0 iff the *x*s form a chain of bound states at t_0.

The bound state view has a number of advantages: first of all, it can be applied to any number of constituents, and allows for composite objects made of other composite objects; it applies to all sorts of physical systems, including both quantum and classical ones, relativistic and non-relativistic, and even to future physics; the criterion of composition is quite sharp, so vagueness is avoided; and the account is extensionally adequate, i.e., it captures all objects we would want it to capture while excluding arbitrary sums, without attributing to them properties which they do not have, such as having continuous boundaries (Waechter & Ladyman 2019: 116-120). It also fits well with the intuition that the way we trace the careers of objects is due to their being *separately movable* things, i.e. “a detached thing that tends to move together with its parts” (Hirsch 1982: 86). Most importantly, the distinction between bound and free states captures a real feature of nature, which relates to the discrete nature of the different energy levels that may be occupied by quantum particles, a phenomenon which underlies the chemical bonds that hold most objects together (Waechter & Ladyman 2019: 117).

On this view, most ordinary physical objects are indeed composite objects not because they

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[53] Luper (2022) defends a ‘bonding’ criterion of composition, but he leaves the definition of ‘bonding’ intuitive and does not engage with physics.

[54] ‘Forming a bound state’ is a monadic predicate, but it nonetheless expresses a relational fact, just as ‘is a mother’ is a monadic predicate that expresses a fact that involves relations and not only intrinsic properties.

[55] This is a rough statement of a complex set of conditions. See Waechter and Ladyman (2019: 109-116) for a detailed discussion of how the bound state view should be formulated taking into account several complications (such as that not all bound states are formed by pairs of particles, that bound states can occur between pluralities of objects, and that composite objects can compose further composite objects).

correspond to the objects of common-sense, but because the matter that composes them is in a bound state. In other words, there are physical forces acting upon the component parts of the object which hold them together. It may be objected that the bound state view says something trivial: things compose something when they're somehow bound together. That is indeed what the view says, but it is not a trivial statement; on the contrary, it is a scientifically relevant view, based on a valid criterion accepted in scientific practice. It is also not vague: in any given situation, there is a fact of the matter as to what the potential energy is and why. For example, the atoms composing a rock are held together by electromagnetism, and the nuclei of the atoms are held together by the strong nuclear force.

Van Inwagen (1990) suggests thinking about the SCQ in a practical way: if we had several nonoverlapping objects, what could we do to get them to compose something? (31). As it happens, we are familiar with a variety of ways in which new objects can be *made*, by bringing about chemical and/or physical processes that *bind* things together. In fact, as pointed out by Julian Husmann and Paul Näger (2018) in their discussion of van Inwagen's account, the putative criteria of composition involving "some type of physical bonding" assessed and rejected by van Inwagen (1990: ch. 6), such as *fastening*, *cohesion*, and *fusion* can indeed generate new physical objects (whereas *contact* is clearly insufficient, because it does not produce bound states). For example, some pieces of paper can be stapled together to produce a new composite object; bricks and mortar together compose a wall; some organic compounds can be baked into a cake; a variety of different components are welded, screwed, or glued to each other in the production of a car; and some twigs and mud are glued together into a solid construction by a nesting house martin.[56]

Although all of these are examples of non-scattered objects, being in a bound state is not the same thing as being non-scattered, and there are indeed some scattered composite objects under the bound state view, namely ones that are gravitationally bound. In most objects with which we are familiar, the main physical force involved is the electromagnetic force, which holds atoms together and is responsible for solid objects maintaining their shape and for processes like gluing things together. This force is both attractive and repulsive, which is why no objects bound by it can be scattered. However, gravity is only attractive, so there can indeed be scattered objects which are nonetheless bound together by gravity; for instance, galaxies. We should point out, though, that the existence of certain scattered objects under the bound state view cannot be used as an argument for a plenitudinous ontology, because they are not arbitrary; they are held together by physical

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[56] Although many of these examples refer to artefacts, they are considered here only as physical objects, and not *as* artefacts per se, although we agree with Waechter & Ladyman (2019) that any account of composition for artefacts should be compatible with the bound state view.

interactions.

Similarly, we agree with Husmann & Näger (2018: 33) that objects that are not fixed to the Earth, like animals and loose rocks, still count as part of the planet, because they are gravitationally bound to it. The same is true of the oceans and other bodies of water on the surface of the Earth, as well as the atmosphere. These objects on the surface of the Earth do not by themselves compose a further object; it is only all the things in a potential well that form an object, not any random plurality of them. Subpluralities of a plurality in a bound state are not, ipso facto, in a bound state themselves – although some of them might be in a bound state together (composite objects can also form further composite objects).

The next section applies the bound state answer to the SCQ to the special case of organisms.

3.2.3. Applying the bound state account of composition to organisms

The main proponents of the bound state view clearly take organisms to be included in this framework. McKenzie and Muller (2017: 235) assume that "[c]ollections of particles that form a living physical object form a bound state", and Waechter and Ladyman (2019) state that any account of how the SCQ applies to organisms should be compatible with the bound state view (108-109). Here we extend the bound state view into the biological realm, by developing an account of organisms as living objects.

Our thesis is that organisms are physical objects of a particular kind, namely living objects. If all physical objects are bound states of matter, and organisms are physical objects, then organisms are also bound states of matter. Organisms are a subset of all composite objects, namely those composite objects that are alive. Hence, there are two conditions for something to be an organism: something is an organism if and only if (1) it is a composite object, and (2) it is alive. Assuming a metabolic criterion of life, this can be stated more precisely as follows:

(1) The *x*s compose *y* at t_0 iff they form a chain of bound states at t_0 [composition], and
(2) *y* is an organism iff the chain of bound states formed by the *x*s at t_0 has the capacity to engage in and coordinate metabolic activities [life]

As we saw in §3.2.1, the physical boundaries of organisms, whether in the form of cell membranes and cell walls, or various kinds of tegument, skin, exoskeletons, and other structures, which are themselves in bound states, are particularly important in making organisms physical objects, as the various component parts of the organism are contained within these boundaries (mainly by electromagnetic repulsion).

Besides these, many other bound states are found within organisms. In particular, weak bonds, which can form between molecules during relatively short periods of time, seem to be essential to a variety of life processes. Consider, for example, the short-term binding of oxygen to haemoglobin, or the temporary binding of molecular chaperones to protein products, which prevent their aggregation before the protein folding process is complete. DNA molecules in cells could also not function properly or even fit within the cell if they were not tightly wrapped around histones, positively charged proteins that bind to the negatively charged DNA molecule.

Organisms are highly complex composite objects which are themselves made of other composite objects. This is not compatible with van Inwagen's account, which admits only organisms and simples, and therefore cannot account for the existence of the organism's components, but is perfectly compatible with the bound state view, which can be extended to composite objects made of any number of other composite objects (Waechter & Ladyman 2019: 118), as long as they form a chain of bound states. This is a clear advantage of our view, since organisms are indeed composed of many composite objects, including complex structures such as ribosomes and cell membranes, without which they could not exist.

Van Inwagen (1990: 89) accepts one case in which organisms are composed of other composite objects: when those composite objects are themselves alive. This is the case of multicellular organisms, which are composed of living cells. However, this is clearly insufficient since not only do multicellular organisms also include non-living parts among their components (e.g., dead skin cells, hair, feathers, nails, tree bark, etc.), but many unicellular organisms, such as bacteria, are entirely composed of non-living parts, many of which are nonetheless composite objects. It is also not the case that any object composed of living parts is itself alive. For example, van Inwagen (1987) offers the hypothetical case of the paralysed handshakers – a case where two people shake hands and then cannot let go because their fingers become paralysed – as a counterexample to 'fastening' as a criterion of composition: "it is certainly not true that an object composed of you and me comes into existence at the instant our fingers become paralyzed" (31).[57]

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[57] Van Inwagen provides no reason *why* bonded organisms do not form a composite object; he just takes it to be obvious. Luper (2022: 24) suggests three possible reasons for this intuition: the fact that we usually tend to care about or be interested in organisms, but not in non-living objects made from organisms attached to each other; the fact that the object thus created is temporary; and the worry that organisms might cease to exist as objects in their own right when they become part of another composite object. The latter is not a worry on the living objects view, which allows for

On the bound state view, however, an object thus composed *does* come into existence. This object is composed of two living objects forming a bound state, but it is obviously not itself alive. Organisms can also form composite objects with non-living objects. We have no objection to Husmann and Näger's (2018: 33) example of the gecko walking on a glass surface and temporarily forming a composite object together with the glass by adhering to it. More problematic cases of composition involving living and non-living objects are discussed in §3.2.4.

The living objects account of organisms obviates the need for a disjunctive criterion of composition such as that suggested by Husmann and Näger (2018), who argue that composition occurs if and only if bonding *or* life occurs; on the contrary, we argue that composition occurs only if there is a bound state; furthermore, some composite objects have the property 'life' (most, of course, do not). This is preferrable not simply on account of being more parsimonious, but also because serious problems quickly arise if there are two separate criteria of composition, both of which can be applied to the same thing: for example, having a disjunctive criterion seems to imply that there are two co-located entities, a physical object and a living organism, with different criteria of identity, whereas on the living objects view, there is only one thing, a physical object which is alive. Husmann and Näger (2018) propose their disjunctive criterion because they believe it is possible for there to be organisms which are not physical objects, but are composed of scattered parts which do not form bound states, such as bee colonies or coral reefs (34). On our view, the bee colony cannot possibly be an organism because it is not even a *candidate* for being an organism, since there is no composite object which has the individual bees as parts.[58]

Olson (2021) argues that all accounts of biological individuality currently on offer are either inadequate or at least incomplete, as they only serve as criteria to decide whether or not something is an organism once there are already some candidate composite objects to begin with: "no definition of 'organism' can be a theory of biological individuality on its own, but only in conjunction with a substantive claim about the ontology of material beings providing the candidates to which the definition is applied" (79). For example, most people accept that, on the genetic view

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organisms to be parts of other composite objects (living or non-living), while continuing to be living objects themselves. Bird (2023) suggests that presumed handshakers' willingness to go to great lengths to separate themselves also plays a role in motivating our intuition in this case.

[58] We have no objection, however, to the claim that the bee colony is a Darwinian individual (Godfrey-Smith 2009), or a unit of selection, or indeed that it exists. Many biological entities, including insect colonies, ecosystems, species, clades, etc, are quantified over by biology, and therefore there is good reason to think that these things exist. They are, however, neither physical objects nor organisms. Thus we agree with Brenner (2018) that scientific quantification over entities that are subject to natural selection does not require those entities to be composite objects.

of biological individuality[59], two identical cells produced by mitosis would not be two organisms, but would instead be part of the same scattered genetic individual. But as Olson (2021: 72) correctly points out, this is so only *if* there is such a scattered object. He also suggests that the disregard for the question of composition in discussions of organismality is only appropriate if an unrestricted account of composition, such as universalism or plenitude, is assumed as an unstated premise (75-76). This is indeed an unmotivated and highly non-naturalistic premise to accept, even more so in the context of philosophy of biology. Notwithstanding the autonomy of biology as a discipline, it makes little sense to develop an account of organismality which is entirely disconnected from any basis in physical science.

Olson's criticism may have gone too far, though, in that those who argue that, for instance, bee colonies, or a collection of scattered clones, are organisms do not need to assume plenitude or universalism; minimally, they are committed only to the view that there are at least some scattered objects. But on what grounds should we accept the existence of these particular scattered objects? Their proponents provide no metaphysical principle – unless they are indeed, as Olson thinks, assuming unrestricted composition. In contrast, on the bound state view, the existence of a physical object is always determined by a single principle: whether or not it is in a bound state.

While there are some scattered composite objects on the bound state view (e.g. large gravitationally bound objects discussed in §3.2.2), as far as we know no scattered objects can be alive, due to the scale at which metabolic reactions take place. The size of the bounded microenvironments which are essential for life as we know it is highly constrained by the sizes of molecules and the need to maintain a surface to volume ratio that allows diffusion to take place at sufficiently short time scales (Schulze-Makuch & Irwin 2018: 41). At such scales, electromagnetic forces are predominant, whereas gravity is too weak to form bound states.

On the living objects view, the bound state account of composition tells us what composite objects exist in the world, and a metabolic criterion of life determines which of those composite objects are alive. On our view, there are no organisms which are not living objects. Conversely, there are also no living objects which are not organisms. It might be tempting to think of isolated organs, such as an explanted liver prior to transplantation, as living objects but, strictly speaking, the liver itself is not alive. Rather, it is the liver cells that are alive – at least most of them, if the liver is still viable. Because most of the cells are still alive, there is indeed metabolic activity going on in this object, but this metabolism and its coordination are carried out by the individual cells, not by the liver as a whole. The liver has no life of its own. Although it is a composite object

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[59] One of the criteria of organismality currently on offer, though not a very popular one.

surrounded by a boundary and composed of living parts, the liver itself does not have its own metabolism, nor does it coordinate its life processes – the cells do, and so did the multicellular organism of which the liver used to be a part.

Although the bound state view is a synchronic account of composition, and does not provide an account of the persistence of objects over time, the living objects view suggests a criterion of persistence for organisms.[60] If something is an organism iff it is a living composite object, then plausibly it persists if the following two conditions are fulfilled: (1) it continues to be a composite object (i.e., there is continuity of bound states, but replacement of parts is allowed), and (2) it continues to be alive (i.e., it continues to instantiate the capacity to engage in and coordinate metabolic activities).

Like all physical objects, an organism persists in virtue of bound physical states which maintain its physical integrity. However, in organisms these bound states are at least partly maintained, and new ones generated, by the activity of the organism itself, powered by energy extracted from the environment. Of course, all objects exist in an environment that may perturb them and so to persist they need to be robust enough. In terms of the bound state view, the kinetic energy needs not just to be lower than the potential energy, but low enough that standard perturbations are insufficient to raise it enough for the parts to escape. Organisms and other biological objects similarly need to be robust under the perturbations that they face in their environments, for example, currents and pressure in water.

Even very robust ordinary objects shed some of their material parts all the time. For example, a granite boulder is eroded to some degree by the wind. Organisms indeed continually exchange matter with the environment. However, over the timescales relevant to the organisms' biological processes, they are bound enough to lose a negligible proportion of their matter. Robin Hendry (2021) points out, in objection to the bound state view of organisms, that a cat is "continuously shedding matter in various directions" (51). This is true, but it is obviously compatible with the fact that the vast bulk of the cat stays bound together over the timescale of the cat's metabolic activity, and replacement of parts takes place gradually.

Organisms persist over time while enough of their physical structure is maintained which confers them the capacity to engage in and coordinate their own metabolic and other life processes (which include maintaining the bound states that constitute this structure); and die if their physical structure is damaged in such a way that those capacities are irreversibly lost. The destruction of the

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[60] It is unlikely that any account of composition can *entail* a thesis about the persistence of composite objects over time, though it may suggest one (van Inwagen 1990: 143).

bound states which constitute the physical structures required for the activities of life amounts to the death of the organism. The living objects view therefore seems to cohere with the Termination Thesis, i.e., the thesis that organisms cease to exist when they die (Feldman 1992: 89-92), because death corresponds to the loss of the bound states which instantiate the physical structures of the organism that confer it the capacity to engage in and coordinate its metabolic processes. When this structure is irreversibly lost, the organism ceases to exist.

It might be objected that the living objects view assumes a clear-cut distinction between living and non-living, when in reality things are not so clear-cut (see for example Dupré & O'Malley 2009). It is true that our account does involve a distinction between living and non-living, but it need not be a completely sharp distinction. Despite this, there are many clear cases of living and non-living things – most objects are clearly either alive or not. Although we would not count viruses as organisms due to their lack of metabolism, they are certainly objects, and our account is compatible with the view that viruses are organisms due to their capacity to coordinate life processes within an infected cell.[61]

The bound state view provides a sharp criterion of composition (Waechter & Ladyman 2019: 117), thus avoiding the charge of vagueness which is often levelled at moderate accounts of composition. However, bound states can have varying degrees of robustness, and there may be objects which are only very weakly bound. For example, a soap bubble is a bound state, but it's a very fragile one; the same can be said of water droplets (which are bound by the hydrogen bonds that attract water molecules to each other, generating surface tension, especially in contact with air).

In organisms it is likely that the capacity to metabolise and coordinate life processes may come in degrees. While it is possible to maintain the view that there must be a clear threshold for life (thus placing any remaining vagueness firmly on the side of our ignorance or our inability to accurately ascertain which is the case for any particular instance), we prefer to accept that it is not possible to avoid all vagueness, because some of it is inherent in the world. Thus there may be cases of objects which are neither clearly alive nor clearly not alive. Nonetheless, the living objects view succeeds in avoiding most of the vagueness that can reasonably be avoided, and provides a clear criterion to decide on the organismality of many problematic cases.

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[61] Our view is, however, not compatible with the process view, according to which organisms are processes, not substances. On the contrary, we argue that organisms are physical objects which are engaged in a variety of processes, but which should not be identified with those processes. We take no view on what a substance is.

3.2.4. Problem cases

Organisms can be entirely composed of non-living parts, or composed of living and non-living parts. Prokaryotic organisms, such as bacteria and archaea, are entirely composed of non-living parts; the whole bacterium or archaeon is the minimum unit which may be considered alive. Eukaryotic organisms, on the other hand, are – or at least were, initially – partly composed of unicellular organisms living inside other unicellular organisms.[62] Multicellular organisms are clearly composed of living parts – the cells. Most multicellular organisms, however, also include non-living objects as parts.[63] The external protective structures of most animals, for example the outer layer of skin which is composed of dead cells, the insect's chitinous exoskeleton, or the calcareous shells of molluscs, are entirely composed of non-living material. The outer parts of tree bark are likewise entirely inert, and so is most of the xylem, the plant's water transport system. Yet in all of these cases, the non-living structures are clearly part of the organism, despite being metabolically inert: they are produced by the organism itself, as part of its life processes, and play a role in its self-maintenance.

Inert objects which are not produced by the organism can also come to be in a bound state with the living parts of the organism. For example, chickens are known to swallow stones which play a functional role in breaking down food in the gizzard. Yet not all material parts of the organism need be functional parts. Objects which are non-functional or even detrimental to the organism, such as kidney stones or a splinter lodged under the skin, can nevertheless be parts of the organism, forming a bound state with its other components, for example by being contained within its boundaries or attached to its structures.

Since the bound state view allows for objects to be composed of other objects, and given that, on the living objects view, organisms are a kind of object, they too can enter into the composition of other objects, including other organisms.[64] Cells in multicellular organisms should on our view be considered organisms that are also part of another living object. Although most of the cells in multicellular organisms usually originate by mitotic division from a zygote, cells with different origins can often become part of it, for example in cases of transplant, gestational microchimerism, embryo reabsorption, or colonisation of the gut, skin, and mucosae by microorganisms. The idea that microorganisms are part of their multicellular hosts is familiar from holobiont theory but, on the living objects view, there is no need to postulate an additional entity;

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[62] It is unclear whether contemporary mitochondria and chloroplasts are alive.

[63] In addition to the non-living parts of their cells.

[64] Composite organisms are discussed in §5.2.

rather, the microorganisms are simply part of the living object which is the multicellular organism. Questions of whether they contribute to the metabolic activities of the host or are tolerated by the immune system do not arise in this context, since material parts of the organism are not necessarily functional.

There is also no principled reason why multicellular organisms cannot be part of other multicellular organisms. An example which is analogous to the case of cells in multicellular organisms is that of zooids in siphonophore colonies. Arguably, both the individual zooids and the colony (as well as the cells) have their own metabolism and coordinate their own life processes – for example, the zooids have their own individual nervous systems but there is also a colony-level nervous system (Mackie 1986). Physiologically integrated symbiotic partnerships, such as lichens, are also easily accommodated within the living objects view. But even multicellular parasites can become parts of organisms to which they attach themselves. In fact, the difference between mutualistic and parasitic associations becomes unimportant for the purpose of individuating organisms, which are simply identified with the living objects present. This is a clear advantage of our view, as it is often hard to ascertain to what degree interspecific associations are beneficial or detrimental for each partner.

In the much-discussed case of mammalian pregnancy, the parthood view, i.e. the view that the foetus is part of the maternal organism, is often contrasted with the containment view, according to which the foetus is a separate organism which is merely contained within the maternal organism (Kingma 2019). On the living objects view, however, the foetus is part of the living object which is the maternal organism precisely *because* it is contained within it, since containment is a form of bound state. This makes it possible to reconcile the parthood and containment views and maintain that the foetus is *both* part of the maternal organism and an organism in its own right. It also allows us to extend the claim that foetuses are part of the maternal organism to all species with uterogestation, regardless of the degree of physiological integration, i.e. including both placental and aplacental viviparous species; and even to other forms of reproduction involving containment, such as the male pregnancy of seahorses.

Even in species with a very high degree of physiological integration, as in the case of humans, who have highly invasive haemochorial placentas, the fusion between mother and foetus is not complete; there is always a boundary at the maternal-foetal interface. The developing human organism, considered as the foetus plus the extra-embryonic membranes, is separated from the maternal environment by the chorion and placenta. Although in this kind of placenta foetal tissue comes into direct contact with maternal blood, the interface is delimited by the syncytiotrophoblast, a specialised barrier made of fused cells which is impervious to most pathogens and even maternal immune cells, while at the same time functioning as a semi-permeable boundary for exchange of nutrients and waste products. The foetus also has its own metabolism and coordinates its life processes to some extent, and is therefore an organism, despite also being a part of the maternal organism.[65]

There are also cases in which two or more organisms form a bound state, but the resulting object is not itself alive. Van Inwagen's (1987) case of the paralysed handshakers, discussed in §3.2.3, is one; a less fanciful example is that of dogs temporarily locked in a copulatory tie.[66] Cell colonies and biofilms, in which individual unicellular organisms adhere to each other but do not form a multicellular organism, are also objects composed of organisms, but which are not themselves alive. Arguably, the same may be said of very early mammalian embryos in the blastula stage, which are composed of several functionally independent living cells held together by a glycoprotein membrane. This multicellular aggregate is in a bound state and moves as a single unit, but does not coordinate its life processes, is not physiologically integrated, and has no metabolism of its own (Brown 2019: 1039).

Finally, organisms can also form composite objects with inert objects. For instance, a lichen growing on a rock can become firmly attached to it and form a composite object with the rock, which has living and non-living components but is not itself alive. Many organisms routinely form bound states with inert objects, giving rise to further composite objects. For example, on the bound state view we should consider that a car is composed of all the objects contained within it or otherwise bound to the main structure, including the driver and any passengers. Though this may seem counterintuitive, it is not as strange as it sounds, since all those things effectively move as a unit, and we do treat them as a single object for some purposes (e.g. for calculating its trajectory). Granted, it may be a relatively short-lived object, but that does not preclude it being an object; in fact, all objects are temporary, they just have very different time spans. Waechter & Ladyman (2019: 116) clearly state that their criterion of composition does not require the long-term stability of the target bound state, but only its existence.

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[65] Kingma (2019) claims that the foetus relies on the maternal organism for many of its physiological functions. It is more accurate, however, to say that the foetus has its own metabolism; for example, it actively transports oxygen and nutrients to its cells using its own cardiovascular system, and exchanges oxygen, nutrients and waste products with the maternal environment at the maternal-foetal interface. It is true that the foetus does not engage in digestion or temperature regulation, but neither do many other organisms – for example, many intestinal parasites do not digest their food since they absorb pre-digested nutrients; and most organisms are ectothermic.

[66] Conjoined twins are more problematic, due to the various ways in which they can be fused and the degree of physiological integration. It seems likely that some cases involve a single organism, whereas in other cases there are clearly two organisms (especially if the twins are only superficially attached).

A summary of the various kinds of composite objects according to whether the object and/or its parts are alive is presented in fig. 2.

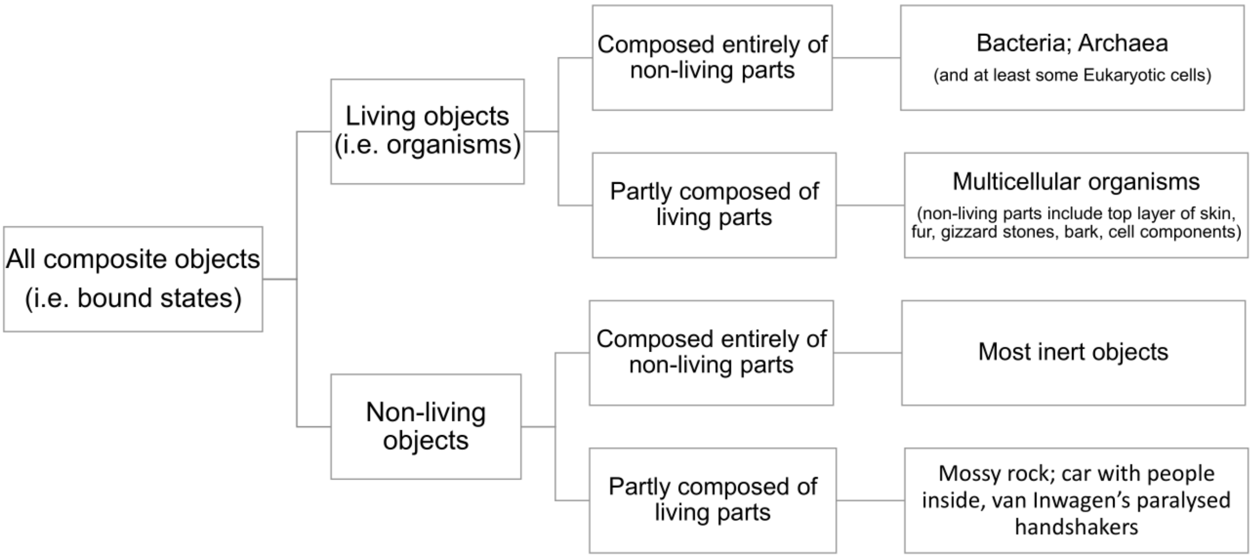

Figure 2. Classification of composite objects according to whether the object and/or its parts are living/non-living.

3.3. Conclusion

The life of an individual organism crucially involves metabolism, which is the controlled exchange of matter and energy with the environment. This requires a physical boundary that allows the organism to maintain a homeostatically controlled environment on the inside of the boundary, where entropy is minimised, and selectively exchange material with the outside. The boundary is itself a physical object, which contains other parts of the organism within it. Thus organisms are necessarily composite physical objects. The living objects view combines a naturalistic answer to the special composition question, the bound state view, with a metabolic criterion of life, providing a scientifically informed metaphysical account of organisms as living physical objects.

CHAPTER 4

Fission, Fusion, and the Persistence of Organisms

Chapter 3 discussed the phenomenon of life and presented a new account of the metaphysical nature of organisms, arguing that they are living material objects, defined on the basis of the bound state view of composition and a metabolic criterion of life. This chapter focuses on the persistence of organisms. §4.1 argues that ‘organism’ is a persistence kind and proposes a simple approach to the persistence conditions of organisms based on the living objects view, but problems related to fission and fusion events, introduced in §4.2 in relation to cells, complicate this approach. §4.3 discusses fission and fusion in multicellular organisms, and §4.4 presents a general account of the diachronic identity of organisms. §4.5 is a brief conclusion.

4.1. ‘Organism’ is a persistence kind

According to the living objects view, presented in chapter 3, organisms are living material objects. Although this view is based on a synchronic criterion of composition, it does suggest a criterion of persistence for organisms. If something is an organism iff it is a living composite object, then, plausibly, an organism persists over time as long as the following two conditions are met:

(1) it continues to be a composite object, i.e., there is continuity of bound states, but replacement of parts is allowed; and

(2) it continues to be alive, i.e., it continues to instantiate the capacity to engage in and coordinate metabolic activities and other life processes.

Jointly, these two conditions seem to amount to an informative criterion of persistence over time for organisms. This does not, however, settle the persistence question. It is only possible to have an account of the persistence conditions of organisms at all if it is either the case that (i) ‘organism’ is a persistence kind, i.e., belonging to this kind implies having certain persistence conditions, such that it is not possible for something to cease to be an organism without ceasing to exist altogether; or (ii) identity is relative, and what we have given are the conditions for something to persist *qua organism*, but one and the same thing could persist as one thing and fail to persist as another. For example, something could fail to persist as an organism but continue to persist as a corpse.[67] My aim is to argue for (i).

Merricks (1998) raises an important objection to the idea that we can provide kind-relative criteria of identity over time. He argues that "the mere fact that there are informative necessary and sufficient conditions for being a *member* of kind K does not, in and of itself, give one reason to think that there are such conditions for the *identity over time* of members of kind K" (Merricks 1998: 113), because being a member of a certain kind and persisting over time "are disparate features of an object" (113). They are indeed and, without further information, we are not in a position to determine whether membership in a certain kind is essential for an entity to persist over time, i.e. whether the kind is a persistence kind. We cannot, that is, conclude anything about the persistence over time of members of kind K, unless we have independent evidence as to whether the members of that kind persist in a certain way. Merricks (1998) does consider this possibility as an objection to his view that there are no criteria of identity over time: "one might respond that we know not only that being a member of some kinds implies persisting, but it implies persisting in a certain manner" (113).

For most kinds of things, our knowledge of the manner in which they persist is insufficient to provide a criterion of identity over time for things of that kind. For example, the knowledge that mountains cannot survive liquefaction does not give us any reason to think we thereby have a criterion of persistence for mountains (Merricks 1998: 113-114). Arguably, we do have some empirical evidence as to how most physical objects persist over time: the bound state view suggests that material objects persist in virtue of the continuity of their bound states, which are maintained by physical forces such as the strong nuclear force, the electromagnetic force, and/or gravitational attraction. These forces *explain* why material objects persist over time, instead of falling apart instantly. Thus, to say that physical objects persist in this manner is not to present a circular argument to the effect that things of kind K have a criterion of identity over time typical of things of kind K and being a member of kind K just is having that criterion of identity over time (Merricks 1998: 112). It is, rather, to provide informative conditions regarding the persistence of physical

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[67] Relative identity is the view that there is no fact of the matter as to whether *x* is identical with *y*; the expression is incomplete, the complete expression would be '*x* is the same F as *y*' (Geach 1967). This view is not as far-fetched as it seems. We do say things like "*x* is the same dog as *y*, but not the same puppy". But we also want to say that there *is* a fact of the matter regarding the persistence of the puppy – it did persist over time, although it ceased to be a puppy. Relative identity precludes this conclusion, and for that reason it should be rejected. See Wiggins (2001) for an in-depth discussion of why identity cannot be relative.

objects over time – conditions that stem from the conditions for their synchronic identity, and which are drawn from important facts about the physical laws that allow composite objects to persist for more than an instant.

The bound state view cannot, however, provide a criterion of persistence for all composite objects. Firstly, as van Inwagen (1990) notes, "[i]t is unlikely that any account of composition can *entail* a thesis about the persistence of composite objects over time" (143). Secondly, even if the bound state view suggests that continuity of bound states has something to do with the persistence of composite objects, it leaves unspecified *how much* of the totality of bound states of an object is required for its persistence. But the bound state view of composition imposes two conditions on the persistence of composite objects: (1) the sudden discontinuity of *all* the bound states of a composite object is incompatible with its persistence; and (2) the continuity of the *entire chain* of bound states of a composite object is sufficient for its persistence. It is implausible, however, that the continuity of the entire chain of bound states would also be a necessary condition, as that would imply that no macroscopic object ever persists for longer than a few instants. More problematically for the case at hand, it would also imply that there are no organisms – since part of what it is for something to be an organism is for it to be able to engage in metabolic activities, which precisely involve exchange of matter with the environment. I take it that we know that there are organisms, and therefore this consequence is unacceptable.

But more can be said about the persistence conditions of organisms. The bound state view is compatible with the existence of different persistence conditions for different kinds of material objects. Organisms are living material objects; therefore, their persistence must also involve continuity of (some unspecified amount of) bound states. These bound states are maintained by physical forces, such as the electromagnetic force. However, some of the bound states of organisms are produced, maintained, and repaired by the actions of the organisms themselves, through metabolic activity, in addition to being maintained by physical forces. This means that we do have informative conditions regarding the persistence of organisms over time. We know that being a member of the kind 'organism' implies not only persisting, but persisting *in a certain manner*. And the fact that organisms are able to persist over time in a way that is distinct from other material objects gives us reason to believe that 'organism' is indeed a persistence kind.

Since the persistence of organisms involves not only continuity of bound states, but also the organism's *capacity* to produce, maintain, repair, destroy and reconstruct its own bound states through metabolic and physiological activities, this suggests that 'organism' is to some extent *functionally* defined. In §4.1.1 I discuss the objection that 'organism' is a functional kind and therefore cannot be a persistence kind.

4.1.1. The ‘organism as functional kind’ objection

Some philosophers, like Wiggins (2001), are happy to accept that substance kinds determine “a principle of *activity*, a principle of *functioning* or a principle of *operation* for members of its extension” (72), which makes ‘organism’ an excellent candidate substance kind, since hardly anything could be a more suitable “principle of activity” than *life*. Others, however, claim that ‘organism’ is a *functional kind*, and these are not generally thought to be persistence kinds. Often, one and the same thing can acquire or lose a function or capacity without thereby ceasing to exist. For example, Olson (1997a: 35) argues that ‘person’ fails to be a substance concept precisely because it is a functional concept, which tells us what something can do, but not what it is; therefore, it cannot provide our persistence conditions.

Peter Nichols (2010) claims that the same is true of ‘organism’.[68] He argues that, in fact, “*[o]rganism* appears to be a *paradigm* functional concept; it is not clear that *organism* picks out any intrinsic, structural features *whatsoever*” (Nichols 2010: 262). Furthermore, he claims, “it is very difficult to see how one *could* define ‘organism’ purely in terms of intrinsic, structural features” (262). But surely the choice is not between a *purely functional* concept and one that is defined *purely structurally* without reference to any functional properties. Admittedly, there may be purely functional concepts that are genuinely substrate-independent – e.g. ‘money’ is a plausible example; ‘person’ might be another (at least if one accepts the theoretical possibility of AI persons and/or immaterial persons). But ‘organism’ is not like that, even if it is defined primarily in functional terms.

Here is Olson’s definition of ‘organism’ that Nichols (2010: 262) claims is a purely functional definition: “anything that has these ‘life-giving’ features – metabolism, teleology, organised complexity – and whatever further properties go along with them, such as self-directed growth and development, an internal genetic plan, low internal entropy, and perhaps the *capacity* for evolution by natural selection” (Olson 1997a: 130). Disregarding the specific details of the properties that Olson picks as “life-giving”, the crucial point here is that “whatever further set of properties go along with them” necessarily includes intrinsic, structural properties. As argued in

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[68] Nichols (2010: 261-264) also claims that ‘human animal’ and ‘animal’ are likewise functional concepts. This is not the case; both terms refer to phylogenetic groups which are defined relationally, not functionally. *Contra* Nichols, the fact that animals are (usually) heterotrophic plays no role in determining whether something is an animal.

chapter 3, life requires physical structure; the capacity for metabolism necessarily requires the presence of semi-permeable boundaries. Metabolism itself is a process that involves exchange of matter and energy in various forms. Growth and development likewise require a physical substrate. While all these features may be realised in different ways, they are not, as in the case of money, entirely substrate-independent. For example, there cannot be immaterial organisms.

Functionalism about life – and, therefore, organisms – is often assumed in synthetic biology, which deliberately tries to test the multiple realisability of biological functions in new and interesting ways. For example, synthetic biologists have come up with foreign genetic base pairs, alternative genetic codes, and proteins featuring noncanonical amino acids (Koskinen 2020). However, an important discovery from these studies is that "the relationship between the material basis of the system and the mechanism through which it achieves its biological function cannot be neatly separated" (Koskinen 2020: 2593). Ultimately, what materials in what arrangements can perform which functions is constrained by the world: "what alternatives are genuinely possible is down to the limitation of the natural world and its physical and chemical principles" (2593). Even if we were to consider hypothetical organisms in possible worlds with different physico-chemical laws, if 'organism' refers to something capable of metabolism, those hypothetical organisms would still necessarily have *some physical structure*, including selectively permeable boundaries, which would allow the exchange of matter and energy with the environment.

The fact that life necessarily requires some structural properties means that 'organism' cannot be a *purely* functional kind – rather, it is partly functional and partly structural. Nichols (2010) anticipates this move, and argues that the same features that motivate Olson's rejection of wholly functional substance kinds should also motivate a rejection of partially functional substance kinds (263). His argument is the following:

> "If a functional property enters into the definition of a concept or kind, that property is either grounded in an intrinsic structure, or it is not. If it is so grounded, then we need not appeal to the functional property in our definition, since the intrinsic structure is doing the work. If it is not so grounded, then we cannot distinguish the kind in question from other kinds without reference to a purely functional property. But that means that our partially functional kind will – in virtue of its kind-defining functional property – be realizable in a variety of internal, intrinsic structures (...)" (Nichols 2010: 263)

The functional properties of organisms – most notably, the capacity to engage in metabolic activity – *are* grounded in their intrinsic physical structure. However, Nichols (2010) does have a point that these functional properties are multiply realised in different organisms.

However, the reason why Olson rejects *locomotor* as a substance kind is not merely because the function of locomotion can be realised by different intrinsic structures; rather, "[b]eing able to move under its own power is just not the sort of feature that could determine an object's persistence conditions" (Olson 1997a: 34). The reason it cannot determine the persistence conditions of things with that property is because the capacity to move is unrelated to how an object persists over time. In contrast, an organism's capacity to engage in metabolic activity is intimately associated with how it persists over time; organisms persist over time precisely by exchanging matter and energy with the environment, repairing and rebuilding their own structures, etc. While this capacity may indeed be a functional property, it is (1) dependent on intrinsic properties such as what the organism is made of and how that matter is organised, and (2) directly related to persistence. Life is precisely a capacity to persist over time in a certain way, namely through a kind of dynamic stability. Therefore, the objection that 'organism is a functional kind', and therefore organisms are not essentially organisms, entirely misses the mark. To be a living organism necessarily involves having the capacity to persist over time in a certain way. Therefore, 'organism' is a persistence kind.

Note that what makes it the case than an organism can persist in this way is its physical structure. The 'sortal property' that makes organisms a persistence kind is grounded in physical, chemical, and biological properties. This allows my account to overcome a main problem with sortalism, which is that it seems to be incompatible with physicalism (Goldwater 2018). This may be true of sortalist views that entail that two physically indiscernible objects can differ in their modal properties. As Olson (1996) argues, the idea that "two material objects, coincident or not, could be exact physical duplicates of one another and yet have different persistence conditions" (381) seems as absurd as the view that there could be two physically indistinguishable vases, only one of which was fragile. But this is not the case with the persistence kind 'organism' – the capacity of organisms to persist over time in a different way from other material objects is grounded in, and explained by, their intrinsic physical properties.

This concludes the discussion of 'organism' as persistence kind. However, although the persistence conditions suggested by the living objects view are a good starting point, continuity-based criteria of persistence face an important challenge from fission and fusion events. In §4.2 and §4.3, I discuss fission and fusion in relation to cells and multicellular organisms, respectively, and in §4.4 I develop an account of organismal persistence that can cope with these challenges.

4.2. Cell fission and fusion

It’s generally assumed that cell division is a process in which one cell ceases to exist and two new cells come into existence (Forbes 1985: 129-130; Wiggins 2001: 83-84, n. 7). This makes sense in the case of symmetric cell division. It can be difficult, however, to adjudicate on the persistence of cells in cases of asymmetric fission and fusion, as well as technological manipulations such as mitochondrial replacement. §4.2.1 discusses the persistence of cells in cases of cell division; §4.2.2 addresses highly asymmetric cell fusion, with a focus on the question of whether the oocyte can survive fertilisation, and §4.2.3 discusses the persistence of cells involves in mitochondrial replacement techniques.

4.2.1. Cell division

“*The dream of every cell is to become two cells.*”
(François Jacob)

Cell division is a process whereby one cell divides, normally resulting in two cells. Bacteria and archaea usually divide by *binary fission*, a process in which a cell duplicates its genome and divides into two cells. Eukaryotes have two main kinds of cell division: *mitosis*, which is similar to binary fission, albeit more complex, and *meiosis*, the process by which gametes are produced in sexually reproducing organisms. Meiosis also involves cells dividing in two, but is a two-step process with two rounds of division for only one gene duplication event. It results in four cells, each with half the original cell’s genetic material. In most cases of cell division, then, there is one cell at the start of the process, and two cells by the end of the process.[69] This implies that at least one cell comes into existence, but it does not settle the question of whether the mother cell goes out of existence and gives rise to two new cells, or whether it survives the process and only one new cell comes into existence.

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[69] Exceptions include multiple fission or schizogony, which occurs in some unicellular eukaryotes (Fusco & Minelli 2019: 89).

In most cases, cell division is symmetric, i.e., the two daughter cells are similar in size, genetic composition, etc. Since none of the daughter cells has a better claim to be numerically identical with the mother cell, the most plausible interpretation is that neither is – in the process of fission, the mother cell ceases to exist, and two new cells come into existence. Asymmetric cell division complicates this picture. It plays an important role in the development of multicellular organisms, allowing for cell differentiation, and also in the renewal of adult tissues from stem cells. Stem cells are undifferentiated cells that have the capacity to divide into a stem cell and another cell that goes on to differentiate into a specialised cell. This kind of cell division is called 'asymmetric division with self-renewal' (Gaziova & Bhat 2007).

The fact that one of the daughter cells – the one which is a stem cell – more closely resembles the mother cell does not lead researchers to assume that it *is* (numerically identical with) the mother cell. On the contrary, the concept of self-renewal in stem cells is defined as the ability of a stem cell to "replicate and generate more of the same" (Fuchs & Chen 2013: 39), i.e., to produce both new stem cells and new differentiated cells. On dividing asymmetrically, stem cells "give rise to both differentiated progenies, as well as undifferentiated stem cells with regenerative potential" (Fuchs & Chen 2013: 40). Are the biologists correct in assuming that the parental stem cell goes out of existence, even in cases of asymmetric cell division? Melinda Bonnie Fagan (2013) thinks so; she characterises stem cell self-renewal as "a process of cell reproduction", and claims that "every cell division event involves three cells: one parent and two offspring" (20).

Another kind of asymmetric cell division is that undergone by the budding yeast, *Saccharomyces cerevisiae*. While in typical cases of cell division, the cell grows, replicates its DNA and other structures, and physically divides in two, in the budding yeast there is an outgrowth of the cell, the bud, which grows, attached to the cell; once mitosis is completed, a septum is assembled, and the bud becomes physically separated from the mother cell (Yeong 2005). Here, researchers talk about the asymmetric cell division forming "a 'mother' cell and a bud"; a mother cell can produce several buds, but "the number of buds produced by a cell is finite" and "[t]he last 2-3 rounds of budding are of longer duration after which the cell ceases to divide" (Gershon & Gershon 2000: 4). The clear assumption in this case is that the mother cell survives division and that numerically the same cell continues to produce buds for a while until it ceases to divide and eventually dies.

It seems, then, that biologists typically assume that cells do not survive either symmetric cell division, or asymmetric cell division of the kind that stem cells undergo, but they assume that cells do survive the kind of asymmetric cell division undergone by the budding yeast. How are we to make sense of all this?

The problem of fission has been discussed in philosophy mainly with reference to hypothetical scenarios involving *human fission* (e.g. Williams 1960; Nozick 1981; Parfit 1984), but it should be thought of as a problem primarily for things that do regularly undergo fission, such as cells. Katherine Hawley (2005) brilliantly summarised the metaphysical problems raised by fission. In the following quote, I have removed the word 'personal' before 'persistence', because as Hawley herself notes, analogous problems arise for accounts of persistence of artefacts, organisms, and other material objects:

> "Fission is a problem for continuity-based accounts of (…) persistence, because persistence through time is meant to be a matter of identity, and identity cannot hold between a single object and two distinct objects. (…) For many kinds of thing, it is initially plausible to think that, for objects of that kind, some continuity relation is both necessary and sufficient for identity over time. The problem is that the logic of identity seems to forbid this." (Hawley 2005: 602-603)

There are several possible solutions to the problem, but each have drawbacks:

> "First, we could argue that identity is not necessarily one-one. Second, we could argue that there are two objects co-located before the 'fission', or that there is a single scattered or multiply-located object after the 'fission'. Third, we could give up the search for continuity-based persistence conditions, or give up the search for persistence conditions entirely. Fourth, we could 'cook up' continuity relations which are guaranteed to be one-one (…) [The latter] usually involves a 'no-branching', 'closest continuer' or 'best candidate' account of persistence"
> (Hawley 2005: 603)

Option (1) is not very attractive; identity does seem to be one-one.[70] Bernard Williams (1960: 44-45) argues that "identity is a one-one relation, and that no principle can be a criterion of identity for things of type T if it relies only on what is logically a one-many or many-many between things of type T" (for example, psychological continuity in the case of personal identity). Additionally, identity should depend only on intrinsic features, and should not depend on a trivial fact (Williams 1960). Parfit (1984: 262-274) counters that, in the case of personal identity, *no* criterion can meet both requirements. Nevertheless, his solution is not to abandon the notion that identity is a one-one relation, but to conclude that identity is not what matters in terms of prudential concern.

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[70] Although van Inwagen (1990) admits that identity can be vague.

Option (2) involves either a metaphysical commitment to co-located entities or to scattered objects. Scattered objects that do not form a bound state are ruled out by the bound state account of composition. Arguably, co-located entities are ruled out as well but, even if they were not, the view is not appealing. Considering that cells are embedded in lineages comprising a vast number of cell divisions, one would have to say that there are not two, but a very large number of cells co-located in each cell – one for each descendant cell however far in the future. This extraordinary proliferation of co-located entities does not faze Robinson (1985: 319), who says that "[i]f amoebae *always* survive fission (…), then however much it appears that the number of amoebae in the world increases, that number can actually only *decrease*. It starts at a maximum, and becomes smaller each time an amoeba dies". This thesis is no more plausible than the doctrine of preformatism.

Option (3) means giving up the search for continuity-based persistence conditions. The problem with these, as Hawley (2005) points out, is that continuity relations are not one-one. This leads Williams (1960) to deny that there is, strictly speaking, spatio-temporal continuity between the original amoeba and the two resultant ones, in a case of fission, because "the normal application of the concept of continuity is interfered with by the fact of fission" (48). Fission, according to Williams, is a discontinuity that prevents the application of the continuity criterion. But it seems far-fetched to deny that *both* resulting amoebae are – spatio-temporally, materially, and biologically – continuous with the original one, as their life processes are continuous with the life processes of the original amoeba, and they share much of their matter and cellular structures with it. Different cases of fission, however, may involve different degrees of continuity. What all this suggests is that continuity-based persistence conditions may provide a necessary, but not sufficient, criterion of diachronic identity.[71]

Prima facie, option (4) does not seem very promising either. The idea of 'cooking up' continuity relations that guarantee a one-one relation is not immediately appealing because it seems to involve stipulation. Like Robinson (1985), I too am reluctant to say that we should settle questions concerning diachronic identity by stipulation. But perhaps a one-one relation might instead be *discovered*, or might otherwise follow from facts about organisms. Wiggins (1980) claims that facts about the "activity of these unicellular creatures" commit us to "count every splitting of an amoeba as the demise of that amoeba" (83). Wiggins grounds this claim on his view about the 'principle of activity' that he believes is characteristic of each kind of living organism; this I find implausible. But the living objects view may also seem to suggest that cells never survive cell division. Certainly, the physical division of a cell involves the breaking of many bound states,

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[71] I will abstain from discussing the alternative option – giving up the search for persistence conditions altogether.

and the life processes, which continue uninterrupted, come to be instantiated in two numerically different cells after the division.

One possible solution to the problem, then, would be to add to the persistence conditions suggested above (an organism persists iff there is (1) continuity of bound states and (2) continuity of life) an additional non-branching clause requiring (3) no change in the number of objects which continue the life processes. This would deliver the verdict that:

(i) Cells never survive cell division.

But this would be a mere stipulation: if organisms can survive losing some of their parts, then whether those parts are also alive should not be what determines whether the original organism survives. This problem, which arises for ‘strictly no-branching’ accounts such as the view that cells never survive cell division (but may survive losing non-living parts), also arises for ‘closest continuer’ or ‘best candidate’ accounts. These accounts violate the ‘*only a and b* rule’: “once we are clear which things *a* and *b* are, [their identity] ought to be a matter strictly between *a* and *b* themselves” (Wiggins 2001: 96), which is problematic because persistence should supervene on local or intrinsic facts, not on the existence and properties of some other object (Hawley 2005: 619).

One account that is consistent with this constraint is Alan Sidelle’s (2000) “over 50% requirement”. The view allows us to compare only the two cells in question, and thus abide by the *only a and b* rule. According to this criterion, if two cells share more than 50% of their material composition, they are numerically identical – there is no need to enquire into the existence or material composition of any other cells. Evidently, any other percentage above 50% would also work, but picking, say, 75% would be arbitrary, whereas ‘more than 50%’ is the minimum that is required to uphold the *only a and b* rule. The over 50% requirement would deliver the verdict that:

(ii) Cells never survive symmetric cell division, but they survive asymmetric cell division.

Sidelle (2000) argues that the over 50% requirement does not actually provide a good theory of the diachronic continuity of material objects, on the basis of counterexamples involving the addition of large portions of matter that are not essential to the continuing existence of the thing in question.[72] He therefore adds a self-sufficiency clause. His account is as follows:

> “A at t_1 is identical to B at t_2 iff (...)
>
> (1) There is a K such that A is a K and B is a K,
> (2) B at t_2 is K-continuous with A at t_1, and
> (3) Two of the following conditions are met:
>   (a) B at t_2 has more than 50% of A’s t_1-matter and more than 50% of B’s matter comes from A
>   (b) the matter shared by A and B comprises a self-sufficient part of both A and B
>   (c) no unshared part of A or B is a self-sufficient part” (Sidelle 2000: 429).[73]

This account is more promising, but it still has problems. Firstly, it is doubtful that material composition could be a relevant criterion of organismal identity. An underlying assumption here is that, if two objects are both continuous with a previously existing one, the one sharing more matter with the original object is the best candidate (Sidelle 2000). But this may not be the most adequate criterion in the case of organisms, which can replace their entire material composition multiple times during their lifetimes. Furthermore, suppose that, after cell division, one cell shares more than 50% of its material composition with the original cell, but the other has more ribosomes and mRNA: it is not clear why having more matter in common with the original cell should trump having more physical structures in common with it, especially structures that are important for the life of the cell.

Secondly, criteria such as having more than 50% of the matter that composed the original cell are very easily fulfilled. And, since cell division is never *perfectly* symmetric, one cell with always end up with slightly more matter, leading to the conclusion that

(iii) Cells always survive cell division.

While nothing strictly rules out this possibility, the conclusion that cells always survive cell division as one of the descendant cells even when division is very nearly symmetric is counterintuitive. The

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[72] See also Luper’s example of Bigly the cat, who survives an operation in which he loses more than 50% of his matter (2022: 49-50).

[73] This is a simplified formulation; see Sidelle (2000: 419, n. 8) for further detail.

main problem, though, is that it makes identity depend on trivial facts, such as which cell ends up with slightly more matter. Therefore, we should reject this option.

Consider again the persistence conditions of organisms suggested by the living objects view: an organism persists iff there is (1) continuity of bound states (but replacement of parts is allowed), and (2) it continues to instantiate the capacity to engage in and coordinate metabolic activities. Since (2) depends on the physical structure of the organism, a more plausible additional criterion would be ‘more than 50% of the physical structure’, rather than material composition:

> (iv) Cells survive cell division as one of the descendant cells iff that cell preserves more than 50% of the physical structure (i.e., bound states) of the original cell and the capacity to engage in and coordinate metabolic activities.

But this is still not quite right – some structures are more important than others. Not all physical structures are essential for maintaining the life of the organism. So, here is a revised criterion that takes this fact into account:

> (v) Cells survive cell division as one of the descendant cells iff that cell preserves more than 50% of the physical structures (i.e., bound states) that allow the cell to engage in and coordinate metabolic activities.[74]

This criterion allows us to say that cells never survive symmetric cell division, since many structures of the original cell that are essential for carrying out metabolic activities are destroyed and rebuilt in the process of cell division so, effectively, each daughter cells inherits less than 50% of these structures. This is also true of many kinds of asymmetric cell division, such as that of stem cells, where the asymmetry is mostly limited to the unequal distribution of regulatory products.

But this criterion also allows that, in some cases of asymmetric cell division, the mother cell survives the process. In the budding yeast, there is an outgrowth of the cell, the bud, which is furnished with materials and structures, and then becomes physically separated from the mother cell (Yeong 2005). Most of the physical structure of the mother cell is preserved (including its scars from previous budding events), whereas the daughter cell is entirely constructed *de novo* during the budding process. Thus, there is good reason to think that in this case the mother cell survives the

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[74] See §4.4 for how this criterion generalises to all organisms.

process and is numerically identical with one of the resulting cells. Nevertheless, there might be cases where it is indeterminate whether the mother cell survives division. We should not be discouraged by this, since vagueness is a pervasive feature of the world – especially in biology.[75]

In conclusion, cell division usually involves a cell ceasing to exist and two new cells being generated. In some cases of asymmetric cell division, however, the mother cell survives fission by retaining most of the physical structures necessary for life; in these cases, cell division generates only one new cell.

4.2.2. Cell fusion and fertilisation

Cell fusion can be seen as the reverse of cell division. The process starts with two cells and, by the end, there is only one cell. As in cell division, there are also symmetric and asymmetric forms of cell fusion. The most common biological phenomenon involving cell fusion is fertilisation or syngamy, the step in sexual reproduction where two haploid gametes fuse to form a diploid zygote. In some species, the gametes are morphologically similar (isogamy), but in most sexually reproducing organisms, they are morphologically quite distinct (anisogamy). Usually, the female gametes are significantly larger and often contain nutrient provision for the first stages of development, whereas the male gametes are usually much smaller and motile. Although both parents contribute equally in terms of the nuclear genome, inheritance of mitochondria and plastids tends to be mostly or completely uniparental.

The widespread view of fertilisation is that two cells, the gametes, cease to exist, and a new cell, the zygote, comes into existence. This seems to be a reasonable assumption in isogamous species. However, most sexually reproducing species are anisogamous, and the difference in size between the male and female gamete can be extreme – in vertebrates, the anisogamy ratio between the ovum and sperm cell often exceeds 10^6 (Parker 1982: 287). Thus fertilisation, in most species, is an extremely asymmetric case of cell fusion – the converse of highly asymmetric cell division. This raises the question of whether the oocyte survives fertilisation.

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[75] For example, Brenner notes that “it is a vague matter which individual organisms are to be included in any particular species”, and worries that “[m]any philosophers will be unwilling to posit this sort of vagueness” (2018: 676). But the vagueness of species boundaries is not a failing of our metaphysical theories; it is a feature of the world which results from facts about evolution and speciation. The unwillingness of some philosophers to accept the vagueness that is inherent in the world constitutes a failure to engage with the world as it really is.

Eugene Mills (2008) argues that the oocyte (i.e. the egg cell) does in fact survive fertilisation, and is numerically identical with the zygote – a claim which he then uses to argue that we do not come into existence at fertilisation. I shall postpone discussion of when multicellular organisms come into existence during development to chapter 5, and focus, for the moment, on the issue of whether the oocyte ceases to exist at fertilisation.

The oocyte is a living cell, so, on my view, an organism (a living object).[76] New cells originate in fission and fusion events, and cells also cease to exist at fission and fusion events – but not always. If cells can sometimes survive cases of highly asymmetric cell division, there is strong prima facie reason to believe that some cells might also be able to survive highly asymmetric cell fusion, which is the case of fertilisation in anisogamous species.

Mills (2008) gives the following reasons to think that the oocyte survives fertilisation: firstly, it is the most natural description of events: "the sperm breaches [the membrane], enters, and dissolves, discharging its contents" (328); the breach in the cell membrane is immediately sealed. This seems like a clearer case of persistence, in fact, than "many other cases that we take as *uncontroversial* cases of organismic persistence" (Mills 2008: 328).[77] It seems implausible, in light of facts concerning the process of fertilisation, and especially the discrepancy in size between male and female gametes, that the oocyte should *cease to exist* following this event. In addition, Mills (2008) argues, should we wish to maintain that the oocyte does cease to exist, it would be impossible to pinpoint the *moment* when it does. The most plausible moments are the moment when the sperm breaches the membrane of the oocyte, and when maternal and paternal DNA are combined, i.e. when the cell becomes diploid.

Again, it is highly implausible to maintain that the oocyte ceases to exist when its membrane is breached. As Mills (2008) points out, cells do not normally cease to exist when their outer layers are breached; there is no relevant difference between the breaching of the membrane in fertilisation and the process of phagocytosis, through which cells such as amoebae and some white blood cells eat bacteria, that would mean that in one case the cell ceases to exist and in the other case not. Concerning the second option, Mills (2008) maintains that it is also implausible because it is better

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[76] Mills (2008) also assumes that the oocyte is an organism, although he claims that his argument goes through even on the simpler assumption that it's a *thing*, by which I presume he means a physical object. Thinking of it as a living cell is also sufficient.

[77] Persistence of the oocyte, that is. The sperm cell does not survive fertilisation, and dissolves. Mills (2008: 332) claims that "[i]ts dissolution is its death" but I think we should say that the sperm cell ceases to exist without dying (see also §5.1 and §5.4).

described as a cell rearranging its parts, rather than anything going out of existence and something else coming into existence.

Mills is correct in claiming that, even if the oocyte does go out of existence at some point, it is impossible to say when. But that in itself is insufficient to show that the oocyte survives; the oocyte might still cease to exist even if it is a vague matter *exactly when* it goes out of existence. But the second option, namely that the oocyte ceases to exist when the maternal and paternal DNA are combined and the cell becomes diploid, deserves further scrutiny, because the biological facts are significantly more complex than that.

In many animals, oocytes prior to fertilisation are not actually haploid cells – not true gametes. They have not completed meiosis. In mammals, oocytes are stored in the ovary arrested in prophase I of meiosis; at ovulation, meiosis resumes but is arrested again at metaphase II. It is at this stage that the oocyte can be fertilised. Upon fertilisation, the oocyte resumes meiosis, completing the second meiotic division producing the ovum, which is the female gamete, and another cell called a polar body. Both of these cells are haploid (i.e. contain only half the chromosomes as a normal animal cell). The polar body contains as much DNA as the ovum, but is much smaller and has very little cytoplasm, and generally undergoes apoptosis. Nevertheless, it is a cell, containing a nucleus, ribosomes, mitochondria, etc (Schmerler & Wessel 2011).[78]

It is arguable whether or not the oocyte survives the completion of the second meiotic division, which produces the ovum and the second polar body. On the one hand, it is a highly asymmetric cell division, and one of the cells – the oocyte – retains most of the physical structure. So, it does seem that it survives this cell division according to the criterion suggested in §4.2.1. On the other hand, this cell division also involves the transition from diploid to haploid cells. Thus, it would seem that, if we want to say that the oocyte ceases to exist at fertilisation, we should also say that the fertilised oocyte also ceases to exist upon completion of meiosis and extrusion of the second polar body, since the two are comparable (both are highly asymmetrical fission or fusion events, and in both cases there is loss or acquisition of a comparable amount of DNA). But this makes it impossible to say that the oocyte ceases to exist upon fertilisation because it becomes a zygote, since the zygote can only result from the fusion of haploid gametes, and the oocyte needs to complete a cell division before it becomes a gamete; only then is it ready to fuse with another gamete to produce a zygote. Furthermore, the very fact that, as a result of fertilisation, the oocyte resumes meiosis – a process *of the oocyte*, not a developmental process of the zygote – gives us additional reason to think that the oocyte does in fact survive fertilisation.

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[78] There are rare cases of twins resulting from fertilisation of the first polar body (Schmerler & Wessel 2011).

If one holds that the oocyte survives fertilisation and also the completion of the second meiotic division, it seems like it might still be possible to argue that fusion of the sperm cell and oocyte begins when the sperm cell breaches the membrane of the (metaphase II) oocyte, which then completes meiosis and becomes a mature ovum, and the process ends when the maternal and paternal DNA are joined together. The egg cell would cease to exist at that point. Understood in this way, it might seem as though the process of fusion of the sperm and egg cell could be considered, after all, as two living things ceasing to exist and one new living thing, the zygote, coming into existence.

But the motivation for saying this would have to come from the importance of the coming together of the two sets of chromosomes. The acquisition of additional DNA does not in itself seem to be a sufficient reason to say that a new organism has come into existence: horizontal gene transfer is a common occurrence in bacteria and archaea, which reproduce asexually but engage in gene exchange through a process called *conjugation*. This seems straightforwardly like a process that cells ordinarily survive. But, if the oocyte/ovum is a single living object throughout, since it preserves most of its physical structure and continues its life throughout these fusion and fission processes (fusion with the sperm cell and completion of meiosis with extrusion of the second polar body), then it would seem strange to say that it finally ceases to exist when the two sets of chromosomes come together. As Mills (2008: 329) points out, this sounds more like a mere rearrangement of the internal structure of a single cell – after all, the additional DNA has been inside the cell (and therefore part of it) since fertilisation.

But it gets worse. While in many animals, the male and female pronuclei fuse in the zygote stage, in mammals, the ‘coming together’ of the maternal and paternal chromosomes in the zygote does not progress beyond the placement of the chromosomes on a common mitotic spindle; the two pronuclei never fuse to form a true diploid nucleus in the zygote, but only in the blastomeres that form the two-cell embryo (Gilbert 2000).[79] This means that the moment when the ovum “has fully incorporated the sperm’s genetic material into its own genetic makeup” (Mills 2008: 329) cannot be the moment when it ceases to exist, either, because this moment *never comes* – not before the first symmetric division of the zygote – by which time the zygote has indeed ceased to exist.

A final argument in favour of the zygote being a numerically different cell from the oocyte/ovum would be that an important way in which the cell engages in and coordinates life processes is related to its DNA. Since the zygote contains both maternal and paternal DNA, there could be a case for saying that it is numerically distinct from the ovum, because it has a different

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[79] This is also the case in many other animals, including molluscs, teleost fishes, and newts (Tarín 2000).

genome, which is important for the coordination of its life processes. The problem with this argument, however, is that the zygote does not in fact use any of its DNA (which, again, at least in mammals, is never united in a common nucleus in the zygote) to regulate or coordinate any life processes; in fact, the zygotic genome is transcriptionally silent (Niakan et al. 2012). The initial stages of embryonic development are strictly controlled by maternal mRNA products that were already present in the ovum:

> “An embryo relies exclusively on maternal gene products, RNAs, and proteins for its early development until activation of its own genome (...) In some animals, such as mice, humans, (...), only the first or first couple of cleavage cycles are accomplished before transcription of the embryonic genome is activated” (Marlow 2010: 2-3)

This might imply that the zygote is not even an organism, since it does not coordinate its own life processes. As Mark Brown (2019: 1038) points out, “[t]he virtual presence of an internal control system is insufficient; operational physical presence is required”. However, if the zygote is numerically identical with the oocyte, which survived fertilisation and second meiotic division, this is not an issue at all, since the maternal products were produced by the oocyte as part of its own life processes, and continue to direct its life processes after fertilisation. Alternatively, it is also possible to argue that, even if the zygote is numerically different from the oocyte and/or ovum, the maternal products, such as mRNAs, that are present in the zygote and regulate its life processes until mitotic division, are in fact part of how *it* is coordinating its life processes, despite the fact that they were inherited exclusively from the maternal cell.[80] But then the basis for saying that the zygote is numerically different from the oocyte or ovum could not be related to how it coordinates its life processes. And it seems that we have exhausted the possible reasons to deny the identity between oocyte, ovum, and zygote. So we should conclude that there is a single cell that goes through these three stages.

Nevertheless, if a single, numerically identical cell survives all these processes, first as oocyte, then ovum, then zygote, its life definitely comes to a (deathless) end when the zygote undergoes symmetric mitotic division, producing an embryo composed of two blastomeres. Discussion of the multicellular development, and the determination of when multicellular organisms come into existence, continues in chapter 5.

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[80] Even if the zygote were numerically distinct from the oocyte, the fact that the mRNA products are *inherited* from a different cell is neither here nor there; after all, a cell’s DNA, which normally has an important role in the coordination of its life processes (though not in the case of the zygote) is also inherited from its ancestors.

However, the claim that fertilisation does not change the numerical identity of the oocyte may seem to have unwelcome consequences for the identity of the multicellular organism that will develop from this cell. On the assumption that the identity of a multicellular organism depends on the identity of its biological antecedents (namely, the parental organisms and the gametes they produce), does the numerical identity of the pre- and post-fertilisation female cell imply that the male contribution makes no difference to the identity of the multicellular organism? Although ‘ovular essentialism’ has been suggested as an alternative formulation of the necessity of origin (Wilkinson 2012; McMahan 2017; Lewens 2021), it does not follow from the claim that fertilisation does not change the numerical identity of the oocyte.

On my view, the zygote is numerically identical with the oocyte and ovum, even though it has already within it the genetic contribution of the other biological antecedent, the sperm cell, which is has incorporated at fertilisation. The presence of the male pronucleus does not change the numerical identity of the oocyte/ovum/zygote, because it has no effect in the coordination of its life processes, but after the two-cell stage, the identity of all embryonic cells is determined by the identity of both sperm cell and oocyte, as their DNA has now been combined, and the combined DNA has an important role in coordinating the life processes of the multicellular organism.

We will now look at another disputed case of diachronic identity of cells, this time involving technological intervention: mitochondrial replacement.

4.2.3. Mitochondrial replacement and numerical identity

Mitochondrial replacement techniques (MRTs) are a set of reproductive technologies used to enable women with mitochondrial diseases to have genetically-related children free from such diseases (Liao 2017). There are two kinds of MRT technology: maternal spindle transfer (MST) and pronuclear transfer (PNT). In MST, the nuclear DNA from the oocyte of a patient with mitochondrial disease is extracted and transferred into the enucleated oocyte of a person with healthy mitochondria. This reconstituted oocyte is then fertilised *in vitro* and implanted in the uterus of the patient. In PNT, a similar procedure is carried out at the zygote stage. An oocyte from the patient with mitochondrial disease and an oocyte from a healthy donor are both fertilised *in vitro*, and the pronuclei of the zygote generated from the patient’s oocyte are extracted and transferred into the enucleated zygote generated from the healthy donor oocyte. The reconstituted zygote is then implanted into the patient's uterus (Tachibana et al. 2009; Craven et al. 2010; Liao 2017: 20-21).[81]

Discussion of the implications of mitochondrial replacement techniques for numerical identity tend to focus on the problem of the numerical identity of the future *children* generated through these procedures. In contrast, I will primarily focus on the numerical identity of the cell.[82] Considering a case of MRT involving either the oocyte (MST) or zygote (PNT), there are three options concerning the identity of the cell produced by one of these procedures: (i) the MRT-produced cell is numerically identical with the cell that contributed the nuclear DNA; (ii) the MRT-produced cell is numerically identical with the cell that contributed all cellular structures except the nuclear DNA; or (iii) the MRT-produced cell is a new cell, originated by the fusion of two cells.

Most of the literature discussing numerical identity in relation to mitochondrial replacement techniques (and the bioethical questions associated with it) makes the assumption that "numerical identity follows the nuclear genome", although this view is not usually explicitly argued for (Palacios-González 2017: 506). On this view, the reconstituted cell is numerically identical with the cell that provided the nuclear DNA. This is a strongly gene-centric view, but there may be some evidence in its favour. After all, genes hold the instructions for building proteins, which in turn carry out most of the life processes of the cell, including regulatory functions. Despite the important role of the genome, however, the "read-out of that genome evidently requires a functional cell at all times" (Harold 2021: 40). DNA by itself is inert; it cannot coordinate the life processes of the cell unless it is actively transcribed, and which parts of the DNA are transcribed or not is itself regulated by extra-nuclear products, such as proteins. Thus, Franklin Harold (2021) concludes that "DNA serves as an indispensable database, but it does not direct the show" (49).

There have been successful transplants of the entire genome of one bacterium species into another, and researchers concluded that the resulting bacterium belonged to the species of the bacterium that provided the DNA (Lartigue et al. 2007). However, this conclusion was based on the fact that the resulting bacterium was phenotypically indistinguishable from bacteria belonging to the

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[81] As is clear from the descriptions, 'mitochondrial replacement techniques' is a misnomer; a better term would be 'nuclear replacement techniques' (Palacios-González 2017: 503). Newson & Wrigley (2017) suggest the alternative 'mitochondrial targeting techniques', but this is equally inadequate, as mitochondria are not directly manipulated by these techniques; nuclear DNA is.

[82] The numerical identity of the oocyte is itself an important question, and its interpretation has legal consequences. For example, in Germany, it is forbidden by law to transfer into a woman "a foreign unfertilized egg" or to attempt "to fertilize artificially an egg for another purpose than bringing about a pregnancy *of the woman from whom the egg originated*" (Cohen et al. 2020: 574, emphasis added). Whether this law allows or forbids MRT depends on the identity of the cell.

donor DNA species, which was ascertained through observation of gene products, namely proteins (Lartigue et al. 2007). Since the DNA of the recipient cell was removed and only donor DNA was present, it is therefore not surprising that only donor DNA was expressed. But this evidence by itself is inconclusive as to whether the post-genome transplantation bacterium is numerically identical with the donor bacterium, with the pre-transplantation recipient bacterium, or is a new organism, produced by the fusion of two bacteria.[83] Since both DNA and cellular structures such as the membrane, cytoplasm and ribosomes make essential contributions to the life processes of the cell, the latter interpretation is the most reasonable in this case.

Liao (2017) argues that MRT involves the creation of a new cell resulting from the fusion of the cytoplasm and other cellular structures of one cell and the nuclear DNA of another. He argues that a cell persists as long as there is *cellular continuity*, which involves "the continuing ability to regulate and coordinate the various life processes", and ceases to exist when this capacity is permanently gone (Liao 2017: 22). This is congenial to the theory of organismal persistence suggested by the living objects view (minus the continuity of bound states requirement); in fact, it's equivalent to the continuity of life requirement. Liao (2017) distinguishes two ways in which this continuity may be broken: *temporary cellular discontinuity*, which can occur, for example, "when an egg undergoes cryopreservation", and *permanent cellular discontinuity*, which is brought about "when it is no longer possible to restart this capacity to coordinate and regulate the various life processes" (23); in the latter case, but not the former, the cell ceases to exist.[84]

With this cellular continuity theory in hand, Liao argues that neither the cytoplasm of a cell, not its nucleus, are identical with the cell itself: both the cytoplasm and nucleus are essential components for a eukaryotic cell to coordinate and regulate the various life processes. The cell cannot be numerically identical with the nucleus, because "most of the life processes that are relevant for maintaining the cellular continuity (…) are in the cytoplasm" (Liao 2017: 23). For example, a eukaryotic cell depends on its mitochondria for respiration, a vital metabolic activity.[85] It cannot produce any proteins without ribosomes, which are also located in the cytoplasm. Other structures are also essential for the persistence of the cell – notably, the cell membrane, without which the cell ceases to exist.

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[83] Note that the post-transplantation bacterium might be numerically identical with the pre-transplantation recipient bacterium even if it has changed species, since organisms do not belong essentially to their species (see Chapter 2).

[84] This is also my own view. See discussions of death and suspended animation in chapter 6.

[85] And, as Liao (2017) also points out, the respiratory function of the mitochondria is partly controlled by the mitochondrial DNA. Although most of the DNA of mitochondria has been transferred to the nucleus over the course of evolution, extant mitochondrial DNA located immediately adjacent to the respiratory membranes is essential to this process (Lane 2015: 243).

But the nucleus, Liao argues, is also an essential component of the cell, which is required to coordinate various life processes. The nucleus “plays an important role in determining what substances should be absorbed and assimilated, how these substances should be metabolized, and how to detect and respond to changes inside and outside [the cell]” (Liao 2017: 23); therefore, enucleating a cell causes it to cease to exist, by disrupting its cellular continuity. It is undeniable that nuclear DNA normally plays an important role in the coordination of the life processes of eukaryotic cells. But removing a cell’s nucleus does not immediately bring about the death of the cell. As Liao (2017) notes, “if the nucleus of egg X is not put back into the enucleated egg, there would be permanent cellular discontinuity and egg X would cease to exist” (23); in other words, it would eventually die. But this is an admission of the fact that removing the nucleus of the cell does not *immediately* cause it to cease to exist. In fact, enucleated cells have been observed to persist for a while, and even show normal behaviour for up to four hours (Goldman et al. 1973; De la Fuente et al. 2019). Mature human erythrocytes (red blood cells), which lack a nucleus, survive for up to 120 days (Harvey 1997).[86]

If the cell survives enucleation – which it clearly does, since it continues to be an object, which preserves most of its bound states, and continues to instantiate the capacity to engage in and coordinate metabolic activities (including respiration) and many life processes – then, *pace* Liao, enucleation does not permanently disrupt the continuity of the cell. In fact, if the enucleated oocyte or zygote did not continue to live throughout the whole procedure, it would not be a viable recipient for nuclear DNA transfer. It could still be the case, however, that the cell ceases to exist when the new nuclear DNA is transplanted into it, and a new cell is thus produced, which originates from the fusion of two cells. This would be equivalent to the case of genome transplantation in bacteria.

The case of MRT, however, is quite different from the bacterial case, where the transplanted genome is immediately expressed by the cell. In MST, nuclear DNA is transferred into an enucleated oocyte; the enucleated oocyte acquires nuclear DNA from a different cell, but this DNA does not coordinate any life processes in the oocyte, since the mature oocyte is transcriptionally silent. The life processes of the post-MST oocyte are coordinated by maternal products that were already present in the cytoplasm, especially mRNAs (Tora & Vincent 2021: 2051). All the structures involved in the coordination of life processes and metabolic activities of the cell come from the enucleated (donor) oocyte, which makes it very plausible that the post-MST oocyte is numerically identical with it. The same can be said of the post-PNT zygote, since it, too, is transcriptionally silent.

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[86] They also lack mitochondria, but produce ATP for their cellular activities by fermenting glucose (Harvey 1997: 177), so they do engage in metabolic activities.

Thus, there is a strong case for saying that the cell that results from MRT is numerically identical with the cell that provides *everything except nuclear DNA*, rather than with the cell that provides the latter. Acquiring DNA from a different cell does not change its numerical identity, since the acquired DNA makes no contribution to the coordination of the life processes of the cell. This is a somewhat surprising result, since the assumption in MRT is usually that nuclear DNA is identity-determining in a way that mtDNA and other cellular structures are not. But again, it is important to distinguish the question of the identity of the cell (oocyte/zygote) and the identity of the multicellular organism that develops from it. Nuclear DNA does make a highly significant contribution to the life processes of the latter.

On the assumption of origin essentialism, the multicellular organism that develops from a cell produced by MRT essentially derives from *all three cells* that go into the composition of the zygote from which it develops. One of the oocytes and the sperm cell contribute nuclear DNA, which is essential for coordinating development and other life processes of the multicellular organism; the other oocyte contributes mitochondria (including mtDNA) and all other cellular structures which are essential for life. Since all three gametes provide essential material contributions to the existence of the multicellular organism that develops from their fusion, all three human individuals who contribute these gametes should be considered biological parents (Baron 2023: 28).[87]

4.3. Fission and fusion in multicellular organisms

Many multicellular organisms undergo asexual reproduction by fragmentation or budding. Often, the fragment that becomes separated from the original organism is a small propagule, and the bulk of the structure of the original organism remains in place. These cases are analogous to the case of asymmetric cell division. For instance, consider a starfish with a severed arm. Applying the criterion of persistence developed in §4.2.1, we should say that the starfish with a severed arm is numerically identical with the original starfish, and the starfish that results from the regrowth of all additional arms is a new starfish that was generated when the arm became separated. Generalising this criterion of persistence to multicellular organisms, we should say that an organism survives

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[87] Currently, British law stipulates that egg donors for the purposes of MRT are not genetic parents, even though they contribute mitochondrial DNA to offspring (Mills 2021).

fission iff there is a living object that preserves more than 50% of the physical structures that allow the organism to engage in and coordinate metabolic activities.

Symmetric or near-symmetric division can also occur in multicellular organisms. For example, suppose that a plant is cut in half, and both halves survive. Does the original plant cease to exist? Cases like these are similar to the case of symmetric cell division. So, we should say that the original plant ceases to exist, and two new plants come into existence. However, while much of the structure of the cell is reconstructed in the process of cell division, resulting in two cells neither of which inherits more than 50% of the physical structures of the original cell, that is not usually the case in multicellular fission. It is possible – indeed, likely – that in this case one of the plants will inherit more than 50% of the physical structures of the original plant. Considering one of the plants to be numerically identical with the original one on this basis seems stipulative, but no other adequate criterion presents itself. However, as in the case of cells, when division is very nearly symmetric, it would be better to consider that neither plant is the original one. Vague cases should also be accepted.

There are also cases of fusion in multicellular organisms that present interesting challenges. For example, plant grafting often involves an asymmetric kind of fusion where one plant contributes the root system and part of the trunk and the other contributes the upper parts and has the reproductive capacity. The resulting plant is numerically different from either of the original plants, because both the root system and the aerial parts contribute equally to the life processes of the plant. Evidently, the fact that the one of the plants retains the reproductive parts does not mean that it retains its numerical identity. Consider a hypothetical case of testicular transplant – the fact that the donor contributes reproductive parts does not incline us to say that the transplant recipient is numerically identical with the donor. Consider also the case of chimerism, often caused by embryonic fusion. In some cases an organism’s reproductive parts originate in a different embryo and express a different genotype. Yet, although the reproductive organs of a multicellular organism contribute to some of the organism’s life processes (especially reproduction and hormonal control of cellular development), they are not usually essential for the organism to maintain its metabolic capacity and coordinate its life processes; therefore, they have no special role in determining the identity and persistence of the organism.

Although rarer than in plants and fungi, there are also cases of fusion in animals. A particularly interesting case is ‘reproductive parasitism’ in Ceratioid fishes. Ceratioids are a group of deep-sea anglerfishes with striking morphology and lifestyle. These fishes exhibit extreme sexual dimorphism. In adult females, the first dorsal fin spine is modified, with a (usually bioluminescent) swelling at the end, the *esca* (meaning ‘bait’), for attracting prey (Pietsch 2009). Males are much smaller than females and lack a luring apparatus, but young free-living males have very well-developed eyes and olfactory organs, which presumably play a role in locating a female. The reproductive strategy of many Ceratioid species involves ‘obligatory sexual parasitism’ (Pietsch 2009: 303-305). The male attaches itself to a female by biting into her, and its jaws gradually fuse with the skin of the female. Often, female Ceratioids have more than one ‘parasitic’ male attached and, in some species, the attachment is permanent. This unusual phenomenon is thought to be an adaptation to mate scarcity in the deep ocean (Regan 1925).

Once attached, the male relies on the female for nutrition, although it is thought that it continues to obtain oxygen through its own gills (Regan 1925; Munk & Bertelsen 1983). More importantly, histological evidence indicates that, in *Haplophryne* sp., there is complete fusion between male and female tissues, and no boundary between them: “the sections show a complete fusion between the snout of the male and the skin of the female”; and “no limits between tissues of the male and the female could be recognized” (Munk & Bertelsen 1983: 58). Furthermore, evidence suggests that their vascular systems are directly connected: “the male vascular system is connected with the plexus of the female skin through an arterial outflow and a venous inflow passing into the superficial veins in the male head” (Munk & Bertelsen 1983: 70). Such an intimate association between genetically unrelated individuals is only possible due to extreme modifications of the immune system in these fishes, in particular the almost complete loss of all components of adaptive immunity otherwise present in vertebrates, a situation which, if transposed to mammals, “would be consistent with the lethal condition of severe combined immunodeficiency” (Swann et al. 2020: 1612).

The fusion between male and female tissues and the absence of any boundary between them, as well as their physiological integration through the vascular system, is consistent with considering the female Ceratioid with any permanently attached, fused males, a single organism. This situation is comparable with the case of fertilisation: there is fusion, but no change in the numerical identity of the female fish, which preserves all the physical structures that allow her to engage in and coordinate metabolic and other life processes, which are not significantly disrupted by the attachment of the male(s). On the contrary, it could be said that the female acquires a further physiological capacity, namely the capacity to fertilise her own eggs. In contrast, according to the living objects view, the male fish does not retain its organismality since, unlike in cases of true parasitism, when fusion is complete there is no boundary between the two former organisms, hence the fused male Ceratioid is no longer a living object.

Pregnancy, in contrast, even when it involves a close physiological connection between the maternal organism and the developing offspring, never reaches a state of complete fusion; gas and nutrient exchange occurs across specialised structures that maintain a semi-permeable boundary between the two. For example, in placental viviparous sharks with yolk sac placentas, foetal and maternal components are separated by the egg envelope, and exchange of nutrients occurs across up to 5 tissue layers (Wourms 1981; Hamlett 1993). In some viviparous teleost fishes, development occurs in the ovary, and secretory projections fill the foetus's mouth and branchial cavity – these are termed a 'branchial placenta'. In this case, maternal and foetal vascular systems "are separated only by a shin sheet of ovarian epithelium and a single layer of gill epithelium", but never come into direct contact (Wourms 1981: 501).

Within eutherian mammals, humans have one of the most invasive kinds of placenta (haemochorial). Yet even in this kind of placenta, there is "a physical barrier separating maternal and fetal circulations" (Renaud & Jeyarajah 2022). In particular, the syncytiotrophoblast, a structure composed of billions of nuclei within a single cytoplasm, that results from the fusion of cytotrophoblast cells (Simpson et al. 1992), functions as a semi-permeable boundary that separates the developing foetus from the maternal organism. Due to its lack of intercellular junctions, as well as biophysical properties such as high elasticity, it forms a physical barrier to pathogens, toxins, and maternal immune cells, while still allowing for selective exchange of nutrients, gases, and waste products (Robbins & Bakardjiev 2012; Zeldovich et al. 2013). For this reason, it is not accurate to say that there is no boundary, or merely a fiat boundary, between the foetus and the maternal organism (Kingma 2018, 2020).[88]

4.4. A general account of organismal persistence

An adequate theory of organismal persistence should take into account both the metaphysical nature of organisms, conceived as living material objects, and also overcome the problems that fission and fusion pose to continuity-based accounts of persistence. It should apply to all kinds of organisms, including unicellular and multicellular ones, sexually and asexually reproducing ones, etc. Considering all these demands, I propose the following general criterion of diachronic identity of organisms:

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[88] Note that, on the living objects view, the foetus is both an organism and also part of the maternal organism (see §3.2.4).

The *essential physical structures account of organismal persistence*:

A is an organism at t_1 and B is an organism at t_2

A=B iff

(1) There is continuity of bound states between A and B;
(2) There is continuity of life processes between A and B; and
(3) At no time between t_1 and t_2 is there a sudden loss, acquisition, or replacement, of >50% of the physical structures that allow the organism to engage in and coordinate metabolic activities.

Conditions (1) and (2) are, of course, the criteria suggested by the living objects view: (1) is necessary for the persistence of all material objects (although the amount of bound states that need to be preserved is left unspecified), and (2) is necessary for the persistence of living material objects, i.e., organisms. However, since it is possible for both conditions to be satisfied by more than one object in cases of fission and fusion, a third condition is necessary. At first glance, condition (3) seems overly complex and ad hoc. However, as we've seen in §4.2.1, appealing to an "over 50% requirement" is not arbitrary, because it is the minimum percentage that allows us to uphold the *only a and b* rule. Also, the criterion does not refer to material composition, which organisms can replace entirely during their lifetimes, but to physical structure.

I understand *physical structure* to involve three aspects: (1) the composite objects that compose the organism (understood in terms of bound states), (2) the bound states that connect them, and (3) the spatial and topological relations among them. Examples of composite objects that compose an organism include proteins, cell organelles, membranes, cells, bones, and well-individuated solid organs – anything that is a composite object according to the bound state view and is in a bound state with other parts of an organism. Examples of (2) would be the bound state formed by all the components of a cell in virtue of being enclosed within a membrane; the bound state formed by all the components of an animal in virtue of being enclosed within its skin or tegument, and the bound states formed between cells, and between cells and the extracellular matrix, through adhesion molecules. Finally, spatial and topological relations include things like the relative spatial positions of organelles within a cell and of cells within a multicellular organism.

Condition (3) does not apply to the totality of physical structures that make up the organism, but specifically to the physical structures that confer the organism the capacity to engage in metabolic activities and coordinate its own life processes. Thus, for example, in a case of fission, one of the resulting organisms may be numerically identical with the original organism despite preserving less than half of its physical structures, if it preserves more than 50% of the structures necessary for life. It is also possible for an organism not to be numerically identical with an organism with which it shares more than half of all physical structures, if it inherits less than 50% of the physical structures necessary for life.

At this level of generality, it is hard to provide much detail about which composite objects, which bound states, and which spatial and topological relations constitute physical structures that are essential for life and which ones do not, but my aim here is not to produce an operational criterion. Nevertheless, it is evident that organismal persistence requires the preservation of physical structures involving components both above and below the molecular scale. Although most molecules would be preserved if the organism was placed in a blender, no organism could survive that adventure. Some cellular structures need to be preserved in all cases, and supracellular structures (or, at the very least, spatial relations between cells) are also required for the survival of multicellular organisms.

Although the criterion of persistence is the same for all organisms, it is worth distinguishing between two situations. One concerns highly complex organisms for which certain specific structures are indispensable, such that their division is not compatible with life. For example, it might be the case that the brain, or the brainstem, is such a structure in the case of vertebrates or, more broadly, that the central nervous system is indispensable for life in all organisms with central nervous systems, and cannot be divided in such a way that more than one organism survives the process. If that is the case, then condition (3) of organismal persistence in these cases may reduce to the continuity of these indispensable parts of the organism. The other situation concerns the majority of organisms, both unicellular and multicellular, for which no particular physical structures are indispensable; in other words, many physical structures are essential for life, but they are interchangeable – for example, it is necessary for life that a certain number of cells should survive, but it makes no difference which ones.

A possible objection to the essential physical structures account of organismal persistence is the observation that organisms continuously replace their physical structures. Molecules such as proteins and cellular structures such as microtubules are continuously broken down and rebuilt; cellular turnover, particularly of blood, stomach, and skin cells, occurs at high rates (although other cells, such as neurons, are much longer-lived). So, even within a single organism's life, there is continuous turnover of physical structures. However, this turnover is gradual – the vast bulk of the bound states that make up the organism are preserved from one moment to the next.

Organisms may, however, survive the loss of very large proportions of their physical structures – though they cannot, on the present view, survive the sudden loss of more than 50% of the structures that are essential for life. This has the unwelcome implication that, in cases where there is a sudden loss of a very significant proportion of physical structures that are essential for life, yet there is only one surviving organism, the surviving organism is not numerically identical with the original one. For example, consider the case of a tree that is struck by lightning, and 4/5 of it is destroyed (for simplicity, assume that no particular parts of the tree are indispensable for life). Although there is continuity of bound states and continuity of life between the original tree and the surviving tree, the essential physical structures account of organismal persistence determines that the two trees are numerically different, due to the sudden loss of more than 50% of the physical structures that allowed the original tree to engage in and coordinate metabolic activities. This may be counterintuitive, but the alternative would be to say that it is the same tree, but only because the other 4/5 of the tree did not survive – if the larger part had survived separately, it would be an even better candidate for being numerically identical with the original tree. This would, however, violate the *only a and b* rule: judgements concerning numerical identity between *a* and *b* should rely only on facts about *a* and *b*. So, the consequence that a tree cannot survive the sudden loss of more than 50% of the physical structures that allow it to engage in and coordinate metabolic activities should be accepted.

4.5. Conclusion

In this chapter, I have argued that ‘organism’ is a persistence kind. Organisms persist in a different way from other material objects; although, like other material objects, they persist in virtue of the continuity of their bound states, some of their bound states are produced, maintained, repaired, destroyed, and reconstructed by the organism itself, through its metabolic activities. Although the living objects view suggests that organisms persist as long as there is continuity of bound states and continuity of life between an organism at t_1 and an organism at t_2, fission and fusion phenomena, which occur both in cells and multicellular organisms, pose a significant challenge, which is solved by the addition of a third condition, namely that an organism only persists if it does not undergo a sudden loss, acquisition, or replacement, of more than 50% of the physical structures that allow it to engage in and coordinate metabolic activities, where ‘physical structures’ are understood in terms of the bound states and spatial and topological relations among their component parts.

CHAPTER 5

Coming into Being and Ceasing to Exist

Chapter 4 argued that organisms are a persistence kind, and developed an account of organismal persistence based on the living objects view, and amended to overcome problems related to fission and fusion. This chapter addresses the issue of the temporal boundaries or organisms, i.e., when organisms come into existence and cease to exist. §5.1 discusses the general question of when organisms come into being and cease to exist, §5.2 introduces the distinction between simple and composite organisms, and defends the notion of composite organism against some objections, §5.3 focuses on the specific case of the emergence of the multicellular organism during development, §5.4 discusses multicellular aggregation and disaggregation, and §5.5 concludes.

5.1. Identifying living objects within life cycles

Organisms are living material objects. Like other material objects, they come into existence, have certain spatio-temporal careers, and cease to exist. Organisms are, however, distinct from other material objects in at least two important ways: first, they have the essential property of being alive, which involves the capacity to engage in metabolic activities; second, they are embedded within a continuous lineage of living entities. With the exception of abiogenesis events, the generation of a new organism always involves both material continuity and continuity of life processes with previously existing organisms.

Being embedded in these continuous lineages, organisms do not simply have spatio-temporal careers; they have life cycles. The simplest life cycles involve an organism growing, duplicating its DNA, and splitting into two – this is the life cycle of prokaryotes. A slightly more elaborate unicellular life cycle involves a vegetative and a germinal phase. This is the life cycle observed in protozoans, unicellular eukaryotes with sexual reproduction. The vegetative cells are haploid (i.e., they have only one set of chromosomes) and transform into gametes, which fuse to form a diploid zygote (with two sets of chromosomes); the zygote then undergoes meiosis to produce haploid cells again (Tarín 2000: 278). Multicellular organisms have more complex life cycles which include both unicellular and multicellular stages. The gametes are invariably unicellular. Some life cycles, particularly in plants, include more than one multicellular organism, a feature known as alternation of generations. In many animals, larval forms and adults can be very different, but it is an open question whether they should be considered numerically different organisms or simply developmental stages of the same organism.

When considering the temporal boundaries of organisms embedded in continuous lineages, we need to identify when *the life of a particular organism* begins and ends, since life itself does not ordinarily begin, but merely continues. Therefore, a good place to start is with life cycles. One promising approach might be to consider the organism "a cyclically repeating segment of a lineage" (Clarke 2010: 317). However, this still leaves the problem of identifying the appropriate segment.

One possibility would be to equate the organism with one complete turn of the life cycle: consider this the *whole life cycle* approach.[89] The whole life cycle approach might indeed be applicable to simple organisms that divide only once, and whose division provides a natural break between 'turns' of the life cycle, since each turn of the life cycle involves only one living object. But it quickly runs into difficulties when applied to even slightly more complex life cycles. In sexually reproducing organisms – even unicellular ones – the life cycle involves both cell division and cell fusion steps. Therefore, in unicellular organisms with sexual reproduction, there are at least two numerically different organisms within a single turn of the life cycle.

Multicellular organisms raise much more significant challenges. Multicellularity has evolved multiple times, and different lineages with multicellular organisms have very different life cycles. In the plant lineage, multicellularity evolved first in the haploid phase of the life cycle, and then also in the diploid phase. Karl Niklas (2016) suggests that we can think of the latter case as "a zygote that has achieved multicellularity" (112), and, similarly, we could think of the haploid multicellular stage as a gamete that has done the same. Early life cycles with alternation of generations involved isomorphic multicellular organisms, but over time distinct selective pressures on haploid and diploid generations resulted in the existence of two very different multicellular individuals within the same life cycle. Although we tend to think of reproduction as "like makes like", much of the time "like makes unlike" (Godfrey-Smith 2016: 816). Even in multicellular organisms like metazoans, which have only one multicellular generation, animals do not straightforwardly produce other animals like themselves. Instead, they produce unicellular gametes, which must then fuse to produce a zygote, which undergoes cell division, eventually resulting in an animal similar to the parental organisms after a prolonged period of development.

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[89] Huxley refers to the organism as "one beat of the pendulum of life" (Huxley 1852: 1849, cited in Clarke 2010: 317).

A *generation approach*, i.e. considering each generation as an organism, may seem more plausible than the whole life cycle approach, since it could apply not only to organisms with alternation of generations, but also to organisms with only one multicellular generation, such as ourselves – in which case we might consider the gametes as a unicellular haploid generation. But it still fails to pinpoint the boundaries of each organism present in the life cycle. In metazoans, for example, in addition to the multicellular organism and the haploid gametes, there is the unicellular zygote and a great many cells belonging to various developmental stages as well as to the adult multicellular organism. Which of these things are organisms, when do they begin, and when do they cease to exist? On its own, the generation approach cannot answer these questions.

In order to identify when organisms come into existence and when they cease to exist, we should combine the conditions for the existence of organisms according to the living objects view with an understanding of the reproductive and developmental processes involved in the generation of new organisms; in particular, the dynamical processes of fission and fusion though which new cells come into existence, and the gradual emergence of composite organisms during development.

Waechter and Ladyman (2019) suggest ways in which the diachronic identity of various inert material objects could be determined on the basis of processes of formation (and dissolution) characteristic of the kind of object and reducible to the occurrence of chains of bound states. For example, the diachronic identity of an igneous rock could be determined by its process of formation, i.e., the way in which this new object comes into being by a process that generates its bound states – in this case, by the cooling of magma (Waechter & Ladyman 2019: 118), and, we might add, its ceasing to exist would be related to processes of erosion or melting into magma, whereby its bound states would be dissolved. Likewise, the diachronic identity of a star could be determined “by a process of gravitational collapse of gas and dust of the interstellar medium, initiating a series of nuclear processes ultimately leading to the formation of a white dwarf, a neutron star or a black hole.” (199). In the case of organisms, their coming into existence and ceasing to exist could also be determined on the basis of processes of formation and dissolution characteristic of organisms, and which can be reduced to the occurrence of chains of bound states coupled with the instantiation, by these, of the capacity to engage in and coordinate metabolic activities.

On the living objects view, organisms are (1) composite objects, understood as bound states, and (2) alive, i.e., they have the capacity to engage in and coordinate metabolic activities. On the basis of these two conditions, three ways in which an organism could come into existence immediately suggest themselves:

(1) A non-living object acquires the property ‘life’;
(2) A previously existing living object divides, originating one or more new living objects; or
(3) Two or more previously existing living objects fuse, originating one new living object.

The second and third options align well with the observation that organisms usually come into being by inheriting materials, structural features, and life itself from previously existing organisms, and that there is no interruption of life processes at reproductive events. The first, however, may seem highly unlikely except in the unique cases of abiogenesis (natural or artificial). Yet the development of composite organisms, and in particular multicellular development, could be described as an instance of a previously existing object, the embryo (which is partly composed of living objects, the cells, but is, arguably, not itself alive) acquiring the property ‘life’, as it acquires, sometime during development, the capacity to engage in, coordinate and regulate *its own* life processes, over and above the life processes of its component cells.

By the same reasoning as above, there are also at least three ways in which an organism can cease to exist:

(i) A living object ceases to be alive, i.e. dies;
(ii) A living object divides into two or more objects, thereby ceasing to exist;
(iii) A living object fuses with one or more other living objects, thereby ceasing to exist.

The fact that organisms can cease to exist without dying aligns well with what other authors have written about death and other ways of ceasing to exist. For example, Feldman (1992) argues that organisms can cease to exist by dying, or by making a ‘deathless exit’ out of life, for example by undergoing fission or fusion, as in the cases of (symmetric) cell division and cell fusion. Feldman is at a loss to explain the difference between deathless and deadly forms of fission and fusion (1992: 71), but the living objects view suggests the following understanding of the two kinds of cases: death involves the loss of life on the part of a particular living object (regardless of whether any of its components are themselves alive); whereas a deathless ceasing to exist through fission or fusion involves the continuation of life processes by one or more descendant organisms, with loss of numerical identity of the biological antecedent(s).[90]

Cells can come into being in two ways: through fission or fusion. They can also cease to exist in these two ways, or through death (for example through necrosis or apoptosis).[91] Although it is theoretically possible for a cell to come into being through a previously existing cell-like object acquiring the property ‘life’, this does not occur naturally – though it might in a situation of artificial abiogenesis.[92] Although multicellular organisms can also be produced through fission and fusion, the main process that results in the generation of new multicellular organisms is development. §5.2 develops the distinction between simple and composite organisms that was introduced in chapter 3, and §5.3 discusses the emergence of composite organisms during development.

5.2. Nested lives: composite organisms

There are good reasons why life comes in cellular packages. As explained in chapter 3, bounded micro-environments are essential for life, and their size is strongly constrained by biophysical and physiological factors – not least, the need to have a surface to volume ratio that allows quick diffusion throughout the cell (Schulze-Makuch & Irwin 2006, 2018). Over the course of evolution, however, natural selection was able to overcome some of these constraints through increases in hierarchical complexity; i.e., by constructing organisms made of other organisms. Two major transitions in evolution are particularly relevant in the context: the evolution of the eukaryotic cell, and of multicellularity. In each of these transitions, there is a significant increase in organismal size, “largely because individuals are composed of multiple components from the lower level” (Heim et al. 2017).

In chapter 3, I observed that organisms can be entirely composed of living parts, or partly composed of living organisms. Here it might be useful to introduce a distinction between simple and composite organisms. While all organisms are composite objects, *simple organisms* are those living objects which are not composed of any parts that are themselves alive; bacteria are a good

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[90] See further discussion in §5.4.

[91] See Durand and Ramsey (2023) for an overview of different kinds of cell death.

[92] It is unlikely that, in natural abiogenesis, a previously existing non-living object would have acquired the property ‘life’; it is more likely that a population of living cells originated from a long sequence of protocells, of which is it indeterminate whether or not they were alive.

example. *Composite organisms*, on the other hand, are those living objects which are partly composed of parts that are themselves alive. All multicellular organisms are composite organisms, since they are composed of cells which are themselves alive. We may call organisms that are part of other organisms *component organisms*.[93]

There is a parallel between my notions of simple and composite organisms and Peter Godfrey-Smith's distinction between simple and collective reproducers. Godfrey-Smith (2015) defines *simple reproducers* as objects that can give rise to more objects of the same kind largely through their own biological machinery, and are not made of smaller parts that also have this capacity; whereas *collective reproducers* are reproducing objects that have parts that are themselves simple or collective reproducers.[94] My notion of simple and composite organisms, however, is broader, as it is not strictly about reproduction, but about organisms more generally.[95]

Luper (2009) accepts that organisms may have component organisms. Although in his recent account of organismal composition he assumes, for simplicity, that organisms do not have organisms as proper parts, he admits that "it seems plausible to say that colonial organisms (and perhaps some other higher organisms) are composed of organisms" (Luper 2022: 46). Accordingly, he makes a similar distinction to my own, namely between *primary organisms* that are "composed directly of molecules" and *secondary organisms* that are composed of primary organisms (Luper 2022: 46, n. 7). Two things, however, are problematic in Luper's account: firstly, the claim that organisms are 'composed directly of molecules' seems to exclude composite objects larger than molecules, such as membranes and organelles, which are also parts of organisms. While van Inwagen, whose ontology admits only simples and organisms, has a reason to deny that organisms are composed of any non-living composite objects, Luper has no principled reason to consider cells and membranes "virtual objects" (2022: 59), since he accepts other composite objects, such as molecules, into his ontology. Secondly, no organisms are exclusively composed of primary organisms – even composite organisms include non-living components as well.

Luper's requirement that the molecules that compose the primary organism be "maximally integrated" (2022: 48), in such a way that they participate in its "autarkic activities" (42) is also

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[93] Peter Simons calls organisms that are proper parts of other organisms *mereo-organisms*, but he explicitly states that his notion does not include organisms that "inhabit a larger one without being parts of it, gut microbiome of parasites for example" (2019: 240), whereas, on the living objects view, these organisms are also part of the larger organism they inhabit, in virtue of being in a bound state with its other parts.

[94] There are also *scaffolded reproducers*, which are entities that rely on external machinery for their reproduction, such as genes and viruses (Godfrey-Smith 2015).

[95] I take it as uncontroversial that there are organisms that cannot reproduce.

difficult to justify, as well as impossible to ascertain in particular cases. For instance, consider water molecules: while individual water molecules may play specific roles in particular biochemical reactions, such as photosynthesis, or in hydrolysing proteins, fats, and carbohydrates (Bagchi 2013: 98), in most biological processes involving water (e.g. stabilising biomolecules through hydrogen bonds, or even macroscopic effects such as turgidity in plant cells), it would make no sense to ask whether an individual molecule is functionally integrated, as the effect is produced by the conjoined presence of many water molecules. In contrast, on the living objects view, molecules are part of an organism because they form a bound state with its other parts, even if they play no functional role in the life of the organism.

At least four objections may be raised against the notion of composite organisms. Firstly, some people may simply equate ‘organism’ with ‘multicellular organism’. But that is not how ‘organism’ is used in biology, where is applies to unicellular organisms such as bacteria, archaea, and protists. Interpreting ‘organism’ to mean ‘multicellular organism’ would exclude most organisms that ever lived; there is no good reason to restrict ‘organism’ in this way.

A slightly more compelling objection is to stipulate that, whenever several living objects overlap, only one of them – usually the largest – counts as an organism. For example, Queller and Strassmann (2009) define organism as “the largest unit of near-unanimous design” (3144). The rejection of the idea that parts of organisms might themselves be organisms is often taken for granted in the biological individuality literature. For example, Ellen Clake (2010) rejects functional integration as a criterion of individuality on the grounds that it is found “in systems we clearly don’t want to describe as biological individuals”, such as “a cell within a metazoan” (316). Disregarding the fact that the cell is evidently a biological individual (at least in the sense of a well-individuated biological object), why would we not want to describe the cell as an organism? Schleiden and Shwann, the original proponents of cell theory, seem to have thought of cells as ‘little organisms’ (Lyons 2020: 79), and many biologists today do too. For instance, Harold (2021) states that “[c]ells are the basic units of life, and each cell is itself an organism.” (49). Yet this does not seem to be the mainstream view.

The rule that something cannot be simultaneously an organism and part of an organism, or an organism and a collective of organisms, is important in Aristotelian metaphysics. The idea is that “all concrete biological particulars are either organisms or parts of organisms or collectives of organisms, and do not belong to more than one of these categories” (Oderberg 2021: 23). David Oderberg notes that “on the traditional understanding of these things, to be a part of an organism is precisely *not* to be an organism, to be an organism is *not* to be a collective, and so on” (2021: 23). This would have been a very sensible position for Aristotle to adopt – a leg is clearly not an organism, and a herd of cows does not amount to an organism either. But it seems far less tenable in the light of cell theory. As Lewis Wolpert (1995) notes, "[t]here was nothing in everyday experience to lead anyone to expect that all organisms are made of cells" (233). Yet the discovery that organisms are made of living cells amounts to the discovery that living organisms are in fact composed of *smaller living things* – whether or not one thinks they should be considered organisms. Aristotle was not in possession of these biological facts, which were only discovered in the nineteenth century.[96] But there is no compelling reason, in the twenty-first century, to expect neo-Aristotelian principles to guide our understanding of the living world.

A more general philosophical argument concerns sortals: it is generally thought that something cannot have proper parts that belong to the same sortal as itself. The three main ideas connected with the notion of 'sortal' are that a sortal should tell us (1) what something is, or what the essence or nature of a thing is; (2) how to count things of that kind; and (3) when something continues to exist, and when it goes out of existence (Grandy & Freund 2023). The first idea comes from Locke's definition of 'sortal', which he derived from 'sort', or kind of thing (1689/1997: III.iii.15); the third is an apt description of a *substance sortal* or, in my terminology, a *persistence kind*. 'Organism', as applied to cells and multicellular organisms, fits both.

The second property of sortals, viz., that they should allow countability, is important due to its link with numerical identity. This is the feature that is often perceived to preclude things belonging to a sortal from being proper parts of something that also belongs to the same sortal. For example, Guarino et al. (1994: 275) think that "the main feature of countable predicates is that they cannot be true of an object and of a nonisolated part of it". Feldman (1973), however, demonstrated that counting and mereological criteria for sortals (as well as essence criteria) are logically independent. For that reason, although Okasha (2022) considers the mereological principle that "if object *o* falls under the sortal *S*, then no proper part of *o* falls under *S*" to be "one of the hallmarks of a genuine sortal term", he does not take it to be a definitive criterion of sortalhood.

In any case, it is not evident that allowing things that fall under a sortal to be proper parts of other things that fall under the same sortal would prevent countability. Wiggins (1967) argued, concerning the Pope's crown that is made of crowns: "There is no definite answer, when the Pope is wearing his crown, to the question 'how many crowns does he have on his head?'" (40). But if the Pope's crown is made of three crowns and is itself a crown, surely the answer is 'four'. Similarly, Elselijn Kingma (2018) says of pregnant organisms that "there is no definitive answer to the question (when pointing to a pregnant organism at any point in her pregnancy): 'how many

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[96] Cell theory was formulated by Theodor Schwann and Matthias Schleiden in the 1830s, although cells had already been observed by Robert Hooke in 1665.

organisms are there?'". But, assuming the question is restricted to multicellular human organisms, if the foetus is an organism, and if organisms can be part of other organisms, the answer it 'two'. There is (1) the *gravida*, i.e. the pregnant organism, which includes the foetus as a part, and (2) the foetus, which, if it is an organism, is a numerically different organism from the gravida.[97] Even if your favourite feature of sortals is that they allow countability, there is still no reason to accept the mereological principle.

There might, however, be biological reasons for wanting to maintain an 'exclusion principle' which states that "if an organism is present at one level, then its parts cannot be organisms and it cannot be a mere part of an organism", namely the apparent incompatibility of the self-maintenance capacity of a composite organism and its parts: "if an object at level *n* in a part-whole hierarchy is an organism, it has a capacity for self-maintenance *in its own right* that is apparently incompatible with it being a mere part of an organism at level *n*+1" (Godfrey-Smith 2013: 26, emphasis in original). Yet it is not evident that this is so. A capacity for self-maintenance is never absolute, but only relative to an organism's environment. In complex multicellular organisms, most of the cells that compose the organism are not in direct contact with the exterior environment (Knoll & Hewitt 2011). The environment of an individual cell in a multicellular organism is composed of other cells and noncellular components. Cells are separated from this environment by a semi-permeable boundary, have their own metabolism, and coordinate their life processes to a large extent, despite also being part of a collective. Therefore, they should be considered organisms.

If there are composite organisms, then, when does this happen? In other words, when do some organisms compose another organism? On the living objects view, for a plurality of organisms to compose a further organism, two conditions are required: (1) the organisms should compose an object (according to the bound state view of composition), and (2) the object they compose should be alive (according to a metabolic criterion of life). For an object to be alive, it needs to have, and coordinate, its own metabolic activities and other life processes. For composite organisms, this means that the composite organism must have, and coordinate, metabolic and other life processes at the composite organism level of organisation – i.e., over and above the life processes of its component organisms.

It is relatively easy for a unicellular organism to direct its own life processes. The coordination of life processes in composite organisms is more challenging, since they are much larger, and may be composed of an enormous number of parts. Nervous systems are a highly effective coordination system evolved by some multicellular organisms, but other coordination

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[97] Even though it is also part of it. There is no inconsistency here: one of my cells is both part of me and numerically different from me; in fact this is true of any object that is part of me.

mechanisms include cell-cell communication, inter-cellular transport of metabolites; vascular and circulatory systems for long-distance transport of fluids, hormones which regulate cell behaviour, and developmental controls, including unicellular bottlenecks, germ-cell sequestration, and maternal control of development.

Similarly, colonial animals, including many species of salps, ascidians, cnidarians, and siphonophores (mainly gelatinous marine invertebrates), have evolved a number of adaptations to colonial life, which allow the differentiation of zooids for different functions, while maintaining a whole-colony coordination of the vital processes. The Portuguese man-of-war, for instance, has zooids specialised in capturing prey (tentacular palpons), which do not feed, others specialised in feeding (gastrozooids), reproduction (gonophores), and a gas-filled float (the pneumatophore), which functions like a sail to catch the wind and allow the colony to be transported (Munro et al. 2019).

Importantly, all true colonies share resources, a feature which sets them apart from mere aggregates (Mackie 1986). This can be accomplished by blood vessels, holes in the cell walls of the zooids, extensions of the gut, or a common gastric cavity. Coordinated behaviour is another feature of true colonies, which can be achieved through the synchronisation of the zooids' individual nervous systems by giant nerve axons evolved at the colony level of organisation, through excitable epithelia in the blood vessels, which also conduct electrical impulses, or other systems (Mackie 1986). Many salp and siphonophore colonies are able to move rapidly and even swiftly change direction, behaving "like a well-integrated unitary organism" (Mackie 1986: 186). In some siphonophores, the colony-level nervous system not only relays responses between zooids but actively initiates behavioural activities, such as swimming (Mackie 1986). On my view, these colonies are therefore composite organisms, since they are living objects that carry out and coordinate life processes at the colony level.

Determining when a composite organism begins and ceases to exist requires identifying when *its own life* begins and ends, over and above the lives of its component organisms. In addition to fission and fusion (discussed in chapter 4), composite organisms can come into existence through two main processes: (a) *aggregation* and (b) multicellular (and higher-order) *development*. Each of these ways of coming into existence also corresponds to a way in which composite organisms can cease to exist, besides fission and fusion: (i) *disaggregation*, or (ii) loss of the property 'life' at the multicellular level. Both entail the death of the composite organism. Multicellular development is discussed in §5.3, aggregation and disaggregation in §5.4, and death is discussed in chapter 6.

5.3. Coming into being: multicellular development

Multicellular organisms usually come into existence through multicellular development, which starts with a single cell, the zygote, and progresses through embryonic development, involving cell multiplication and differentiation. On the living objects view, the multicellular organism comes into being when there is a multicellular living object, i.e. there is an *object* composed of cells that is *alive*, i.e. has the capacity to engage in and coordinate metabolic activities and other life processes, at the multicellular level of biological organisation – over and above the metabolic activities and other life processes of its component cells. The question then is to identify when this happens.

However, the view that the life of a multicellular organism, such as an animal, starts at fertilisation, is widespread. This view implies that the multicellular organism is numerically identical with the zygote from which it develops. In §5.3.1, I present several reasons why the multicellular organism cannot be identical with the zygote before assessing, in §5.3.2, when, during development, the multicellular organism begins to exist.

5.3.1. The life of a multicellular organism does not start at fertilisation

It is natural to identify the process of fertilisation with the beginning of the life of a multicellular organism, because it is the most natural place to locate the 'turn' of the life cycle. Fertilisation is the culmination of sexual reproduction, when the haploid gametes unite and the diploid part of the life cycle begins. Yet neither the whole life cycle approach nor the generation approach (§5.1) can help us identify the temporal boundaries of the organisms present in the life cycle of a multicellular organism. The fact that both the zygote and the multicellular organism that develops from it are diploid and share a genome does not automatically make them numerically identical.

It is often assumed that there is a single entity that is somehow transformed from unicellular to multicellular: "[t]he developing entity, while remaining in some sense a single individual, transitions from the cellular to multicellular level of biological organisation." (Fagan 2018: 114-115). This implies that (1) the zygote is an organism; (2) the multicellular organism is an organism; and (3) zygote and multicellular organism are numerically identical. Claim (2) is indisputably true. I also accept (1), but reject (3), on the grounds that the zygote does not survive cell division, and the early embryo is not an organism; therefore, there is no entity that persists throughout the entire developmental process. Rather, the zygote ceases to exist when it divides, and the multicellular organism emerges later during development.

One reason to hold that fertilisation marks the start of the life of a multicellular organism is the claim that the zygote is an organism. Maureen Condic (2020), for instance, argues that the zygote is an organism, because its parts interact in support of an integrated whole, and furthermore, it is a *whole* human organism, because, unlike other human cells, it is not part of another human organism. As Brown (2019) points out, however, Condic does not identify any plausible candidate for an internal control system in the zygote. Although maternal and paternal genomes are both present in the zygote, they are still physically separate until first mitosis (Reichmann et al. 2018), and the zygotic genome is transcriptionally silent – its life processes are coordinated by maternal products already present in the oocyte (Marlow 2010: 2-3; Hasley et al. 2016: 147). For this reason, Brown (2019) considers that the zygote is not an organism, since it does not actively regulate physiological homeostasis, unlike, for example, an amoeba.

It seems excessive to deny, however, that the zygote is a living cell. It is clearly a living object, which has metabolic activity (Biggers et al. 1967; Dumollard et al. 2008). Furthermore, if my claim that the zygote is numerically identical with the oocyte is correct (§4.2.2), then the zygote does coordinate its own life processes, by means of maternal products (mRNA, proteins, etc), that were produced and deposited by this very cell during oogenesis. On the living objects view, the zygote is an organism – but only in the sense that any other living cell is an organism, including the cells in a multicellular organism. It does not follow from the fact that a human zygote is both human (because it belongs to the human species) and an organism (because it is a living object) that it is a "human organism", a "human being" (Condic 2020: 9) or a "human animal" (Luper 2022: 61), any more than any of my cells is a human organism. As Brown (2019) states, "[t]he zygote may be alive in the sense that a human cell sustained in culture is alive, but the evidence does not support the claim that it is a somatically integrated human organism" (1038). Even granting the claim that the zygote is 'a human organism', it would still not follow that it is numerically the same organism as the multicellular human organism that develops from it.

Two arguments are often given against the view that the zygote is identical with the multicellular organism which develops from it, but neither is very compelling. One is the twinning argument (Anscombe 1984; Guenin 2007; Condic 2020): considering a human zygote to be numerically identical with the adult human individual because it has the potential to develop into an adult human individual runs into trouble because the same zygote also has the potential to develop into *two* adult human individuals, should it divide and produce monozygotic twins. And this may be true of all zygotes, even those that do not in fact give rise to twins, "in so far as they all have the natural active potential to form identical twins that may develop into adults, given suitable conditions" (Ford 1988: 120).[98]

Many find this argument compelling. Van Inwagen (1990) says that it seems to him "most implausible to suppose that the developing embryo is yet an organism if it is still at a stage at which monozygotic twinning can occur" (1990: 154). Liao (2010) frames the argument in the following way: "[t]he fact that something has the potential to undergo twinning and give rise to two new beings means that there is not actually a unique being there" (62).[99] But this argument is highly questionable, since an amoeba can potentially divide at any time; but that does not prevent it from being a single, unique organism before it does (Liao 2010). Barry Smith and Berit Brogaard (2003) agree that "the identity of the amoeba persists across an interval during which it is susceptible to fission but does not, in fact, divide" (68-29). Luper (2022) also favours the amoeba objection:

> "Although an embryonic organism that *does* twin ceases to exist, I do not think we should conclude that no human animal yet exists because it is at a stage where it *could* twin. To do so is like denying that any (asexually reproducing) planarian or any amoeba is an organism on the grounds that it could divide (or be divided) at any time, and if divided, it would give rise to distinct organisms." (Luper 2022: 59, n. 13)

Indeed, Louis Guenin (2008) notes that, for organisms which reproduce by division, "[n]either the possibility nor actuality of dividing and separating impugns their individuality" (71) prior to division.

However, Brown (2021) argues that the analogy with fission in unicellular organisms is misleading: where cell division "is a multistage process requiring DNA synthesis, alignment of organelles, and parallel closure of cellular membranes", monozygotic twinning of the early embryo is not a complex biological process initiated by a living cell, but simply "results from a breach in the zona pellucida", which allows "two or more totipotent blastomeres to float away in the supportive environment of the fallopian tubes, where each reinitiates blastomere cleavage" (676). It is precisely because early embryos are not integrated organisms that twinning by blastomere

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[98] The zygote can also fail to develop into a human organism at all, and develop into a hydatiform mole instead (Bedate & Cefalo 1989).

[99] Other individuation problems occur with 'fusion chimaeras', where a single multicellular organism results from the fusion of two embryos originally produced by two separate fertilisation events (in rare cases, one sperm cell fertilises the oocyte and another fertilises a polar body); evidently, the multicellular organism that develops from this fusion cannot be numerically identical with either of the original zygotes (Smith & Brogaard 2003: 59).

dissociation is possible (Brown 2021). Fission, in the form of cell division, is the right account, not of twinning, but of the first mitotic division of the zygote into two blastomeres. It is this division, rather than either actual or possible twinning, that raises problems for the continuity of the zygote into the blastula stage (more on this below).

A related argument has to do with totipotency: "the cells of the embryo that exist while twinning is still possible are totipotent" (Liao 2010: 63) as, of course, is the zygote itself. This may be true, but it is unclear what its implications should be.[100] As Liao (2010) notes, many organisms (such as many plants) have cells that remain totipotent all their lives. This fact does not seem to preclude such organisms being unique and distinct individual organisms, so it is not clear that totipotency per se should be seen as having important consequences for organismality.

More important, perhaps, is the fact that only some cells in the early embryo go on to form the multicellular organism; others go on to form the placenta and yolk sac. In mammalian embryos, cells positioned on the outside layer of the blastocyst form the *trophectoderm*, which gives rise to the embryonic part of the placenta, whereas cells positioned on the inside form the *inner cell mass*, which further differentiates into the primitive endoderm, which contributes to the formation of the yolk sac, and the *epiblast*, which develops into all the cells of the foetus (Płusa & Piliszek 2020). In fact, most of the cells in the early embryo do not contribute to the formation of the tissues of the future organism, but instead contribute to the formation of the placenta and yolk sac, structures that are essential for successful implantation and development. Therefore, neither the zygote not the early embryo can be identical with the foetus, which develops only from a subset of cells in the blastocyst.

An even more compelling argument for why the multicellular organism cannot be identical with the zygote it develops from is the one recently developed by Chunghyoung Lee (2022). Lee appeals to facts about plasticity in early development, namely, the fact that it is indeterminate which cells of the 16-cell embryo go on to develop into the future multicellular organism and which ones go on to develop into the placenta, to argue that a numerically different organism could have developed from the same zygote, even in the absence of twinning. At the 16-cell blastula stage, the inner cells (slightly less than half) go on to form the inner cell mass, and the rest form the trophoblast, which develops into the placenta. Lee (2022) points out that, at least in mammals, which cells end up in the inner cell mass is not predetermined, as is the case in many other animals (Płusa & Piliszek 2020), but is to some extent specified by environmental, topological, and

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[100] Although there may be differences in blastomere totipotency already at the 2-cell stage, probably due to differential spatial localisation of maternal products in the oocyte causing their unequal distribution at first cleavage (Casser et al. 2017, 2019).

mechanical factors during development (Samarage et al. 2015; Chan et al. 2019; see also references in Lee 2022). Therefore, an organism that actually developed from a certain cluster of cells could have developed from numerically different cells, namely the ones that gave rise to the placenta. Given certain origin essentialist assumptions, this organism would be numerically different from the organism that developed in the actual world, despite originating from the same zygote (Lee 2022). Therefore, (mammalian) multicellular organisms cannot be numerically identical with the zygote they develop from.

Both of these arguments, however, rely on the assumption that the placenta and related structures (the ‘extraembryonic structures’) are not part of the organism. But, as Guenin (2008) argues, “the presence at any earlier stage of cells destined for supporting structures” could instead simply mean that “the developing individual will develop a part through which it will obtain nutrition during its gestational life” (97). These structures are indeed important for the metabolic activity of the developing organism. But are they part of it? Kingma (2020) distinguishes between three possible conceptions of the foster.[101] According to the *Future Baby View*, the foster consists of “*only* that part of the pregnancy material that will emerge as the future baby”; the *Baby with Placenta View* holds that “the foster consists of the future baby *plus* the umbilical cord and placenta”; finally, according to the *Chorionic Content View* “the foster consists of *all of* the pregnancy material as surrounded by the chorion and derived from the zygote: that is, this includes the future baby, the umbilical cord, the placenta, the amniotic fluid, the amniotic and chorionic membranes” (Kingma 2020: 376-381, emphasis in original). She argues that, on any of these views, it is not possible to identify a real boundary between foster and maternal organism.

Kingma’s observation that there is no real boundary at the umbilicus, or anywhere along the umbilical cord, is a problem for the Future Baby View, since for the developing foetus to be an organism according to the living objects view, there must be a real (though semi-permeable) boundary separating it from the maternal organism. However, a different problem is immediately evident for both the Baby with Placenta and the Chorionic Content views: namely, the fact that monozygotic twins can sometimes share a placenta (monochorionic twins), and even a common amnion (monochorionic, monoamniotic twins). According to either the Baby with Placenta or Chorionic Content views, we would have to count monochorionic twins as one organism. Surely, this conclusion should be avoided, since twins can have different metabolic activities, and it is possible for one to die while the other survives. Furthermore, it is plausible that the amnion,

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[101] *Foster* is a technical term introduced by Smith and Brogaard (2003) to refer indifferently to zygote, embryo, or foetus. I prefer to use the more specific terms when possible, but here I follow their usage.

including the amniotic fluid, is not part of the foetus, because the foetus interacts metabolically with it as it would with an external environment, e.g. through respiration, swallowing, and urination.

As I argue in §3.2.4, however, there *is* a natural boundary between the developing foetus and the maternal organism: this boundary can be found at the syncytiotrophoblast, which forms a barrier between the maternal and foetal blood circulation (Renaud & Jeyarajah 2022). Thus, my conception of the boundaries of the foster is a modified version of the Baby with Placenta View, which might be termed the '*Metabolic Foetus*' view: the foetus is composed of the tissues that will become the future baby, *plus* the umbilical cord and syncytiotrophoblast, which marks the boundary of the embryonic side of the placenta.[102] But, if at least some placental structures are part of the developing organism, this considerably weakens the arguments based on the fate of cell lineages in the early embryo.

The main reason why the zygote cannot be numerically identical with the multicellular organism that develops from it is that no single entity survives from zygote to embryo to adult. On the contrary, the zygote – which is a living cell, hence an organism – ceases to exist upon completion of the first mitotic division. Here is van Inwagen's description of the situation:

> "The zygote was a single, unified organism, the vast assemblage of metabolic processes that were its life having been directed by the activity of nucleic acid in its nucleus. No such statement can be made about the two-cell embryo. No event, I should say, is its life. The space it occupies is merely an arena in which two lives, hardly interacting, take place." (van Inwagen 1990: 153)

Disregarding the inaccuracy concerning how the zygote coordinates its metabolic processes, already discussed above, van Inwagen's account seems broadly correct.

Liao (2006) disputes this interpretation. He argues that "the zygote survives as a two-cell organism, because growing by increasing cell numbers still involves coordinating various life processes" (349, n. 12). But cell division, per se, cannot distinguish between growth of a multicellular organism and reproduction of a unicellular organism by cell division. Norman Ford (1988) notes that the fact that "mitosis is a purposive process directed from within the zygote (...) does not mean that it results in a two-celled individual rather than two individual cells" (126), any more than the fact that mitosis is a purposive process directed from within a dividing amoeba means that it results in a two-celled amoeba, rather than two individual cells. Liao (2006) argues that, in

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[102] Even monochorionic, monoamniotic twins have separate syncytiotrophoblasts (Kusanovich et al. 2008).

this case, however, “unlike a dividing amoeba, the daughter cells of the embryo will not just wander off, but will communicate with one another in order to coordinate further development” (349, n. 12). Hence, he concludes that this kind of coordination of life processes is sufficient for the two-cell embryo to be considered a single organism.

But there is little coordination, and practically no communication, between blastomeres at the 2-cell stage. Up to the 8-cell stage, in fact, cells lack the capacity to form gap junctions (Lo & Gilula 1979). Brown (2019: 1039) notes that “[c]leaving blastomeres interact so weakly that a rupture in the outer membrane can result in decomposition into two or more blastomeres that then undergo separate embryological development as identical twins”, which indicates the “nearly complete absence of integrative unity” in the early embryo. Until compaction and formation of the morula (which in humans happens at the 8- to 16-cell stage), the blastomeres are only “loosely attached” (Płusa & Piliszek 2020). The reason the two cells do not simply ‘wander off’ is that they are enclosed within the *zona pellucida*, a polypeptide left over from the ovulated oocyte which holds the cells together (Brown 2019).

The zona pellucida “gives the *appearance* of a single organism or unity by holding the eight distinct individual cells together” (Ford 1988: 137, emphasis added). Paez (2016) even claims that “before gastrulation what we call an ‘embryo’ is not an individual object. It is a collection of organisms” (438). As noted in §3.2.4, however, the fact that the cells are enclosed in the zona pellucida makes the early embryo a bound state that moves as a single unit, i.e., a composite object, but, although it is partly composed of organisms, this object is not itself alive – it is not physiologically integrated and does not coordinate its life processes; hence, it is not an organism.[103] So the zygote cannot survive as a two-cell embryo.

Note that the problem is *not* that “[i]f there are many organisms at this stage, then, so the argument goes, there cannot be a distinct individual to whom one can be numerically identical” (Liao 2010: 63). On the living objects view, the existence of many cellular organisms is perfectly compatible with the existence of a multicellular composite organism. The problem is that the blastomeres do not in fact form an integrated multicellular organism. Therefore, it is impossible for the zygote to be numerically identical with the multicellular organism that develops from it, because *no single entity* survives from zygote to adult. In the early embryonic stages of development, multiple organisms exist – the individual cells – but no multicellular organism is present. Instead, the multicellular organism, a living object partly composed of other living objects, emerges during

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[103] Damschen et al. (2006) are impressed by the fact that the blastocyst is contained within a physical boundary, and “can be counted along with other blastocysts in a Petri dish” (172). But being a discrete *composite object* is not sufficient to make it an organism.

development when the developing embryo acquires the capacity to engage in and coordinate metabolic and other life processes. §5.3.2 discusses when this happens.

5.3.2. When does the multicellular organism begin to exist?

If the early embryo is not an organism, then the multicellular organism begins to exist at some point during development. There is no shortage of alternatives for when this happens. Smith and Brogaard (2003) list the following possible thresholds for the beginning of the life of a human organism:

> a. The stage of the single-cell zygote (day 0)
> b. The stage of the multi-cell [blastula] (days 0-3)
> c. The stage of the morula (day 3)
> d. The stage of the early blastocyst (day 4)
> e. Implantation (days 6-13)
> f. Gastrulation (days 14-16)
> g. Onset of neurulation (from day 16)
> h. Formation of the brainstem (days 40-43)
> i. End of first trimester (day 98)
> j. Viability (around day 130)
> k. Sentience (around day 140)
> l. Quickening (around day 150)
> m. Birth ([around] day 266)
> n. The development of self-consciousness (some time after birth)
>
> (Smith & Brogaard 2003: 58)

In the previous section, I rejected (a) and, to some extent, (b). There is an additional threshold within (b), however, that is worth considering. That is the activation of the embryonic genome that occurs at the *midblastula transition*. After a certain, species-specific number of cell divisions, zygotic genome activation begins, along with clearance of the maternal RNAs and proteins that have been coordinating development until that point (Zhang et al. 2017). In humans, this takes place between the 4- and 8-cell stages (Płusa & Piliszek 2020). This seems like a promising option, because it marks the point at which the embryo begins to coordinate its own development. Both Liao (2010) and Luper (2022) argue for the view that organisms begin to exist at conception because they are under the impression that this is the case already in the zygote; it is not, but if it is the case at midblastula transition, then this could mark the beginning of the life of the multicellular organism.

However, Brown (2019) argues that the early embryo lacks a life-regulation internal control system than can be attributed to the organism as a whole. The early embryo is a ‘mere organic aggregate’, which “may have an external boundary and internal structure, and host ongoing biological processes, but nothing within the aggregate integrates the output of these processes in support of physiological homeostasis” (Brown 2019: 1036). This seems right; the fact that there are several cells which now have their own genomes directing their life processes does not automatically translate into the existence of a multicellular organism that coordinates life processes at the multicellular level of biological organisation. As noted in §5.3.1, there is very little interaction between the loosely attached blastomeres at this stage. Instead, each cell is directing its own life processes, without any overarching coordination or metabolic activity on the part of the collective. Something similar can be said of (c) the morula and (d) the early blastocyst; although there are self-organisation processes going on during these developmental stages (Płusa & Piliszek 2020), it is not clear that there is any multicellular-level coordination of metabolic activity going on.

Brown’s *somatic integration* view is, in principle, quite compatible with the living objects view. Brown (2019) considers organisms to be “organic composites that consist of an outer membrane that permits bidirectional exchange of matter and a complex internal state that actively resists entropy” (1036), and by ‘somatic integration’ he means “the regulation of dedicated homeostatic mechanisms that maintain physiological homeostasis conducive to cellular metabolism” (1036). However, the somatic integration definition of life has been criticised for relying too strongly on a definition of death which is only applicable to “postnatal human beings” (Blackshaw & Rodger 2020). This criticism is peculiar, especially considering that these authors oppose abortion, which means they must agree that prenatal human beings can also die. In fact, foetal death “is determined by the same respiratory and circulatory criteria as are used to determine life and death in newborn infants” (Brown 2021: 675).

It is reasonable to require that “the property we lose when we die must be the very property we gain” when we begin to exist (Burgess 2010: 69), as long as one is careful to distinguish between a property that is acquired when the multicellular organism begins to exist and lost when it ceases to exist, and specific features which can be used to ascertain whether a particular object is alive or not. In the case of death, the first corresponds to a *definition* of death, such as “the irreversible loss of functioning of the organism as a whole” (DeGrazia 2014: 82), while the later can refer to specific *standards* of death, such as the whole-brain standard, the cardio-pulmonary standard, etc, which may not apply to all developmental stages. But somatic integration, as defined by Brown (2019), does not rely on standards of death at all; it relies on a definition of life, which applies “quite generally to organisms at every developmental stage” (Brown 2021: 675), and even to unicellular organisms.

Considering organisms as living objects, the life of a multicellular organism begins when an object that is composed of cells acquires the property *life*, i.e. when it acquires the capacity to engage in and coordinate metabolic and other life processes, at the multicellular level of biological organisation. This is remarkably similar to Brown’s somatic integration view. My broad agreement with Brown, however, still leaves open the possibility of disagreement as to *when*, during development, the multicellular organism reaches the threshold of somatic integration.

Implantation (e) might be a promising threshold for organismal life since, when implantation is complete, the embryo can begin to obtain nutrients for its own growth and development directly from the mother’s blood supply (Smith & Brogaard 2003: 61). Considering the importance of metabolic activity for life, this could mark the onset of the life of the multicellular organism, since the invasion of the decidua and establishment of contact with the maternal blood vessels is a coordinated action involving more than just individual cells. Crucially, however, this process also involves the cooperation of the maternal organism (Stadtmauer & Wagner 2020). Furthermore, preimplantation embryonic stages also have metabolic activity (Leese 2012) and even obtain nutrients from the mother which are secreted by uterine glands (Gray et al. 2001). There is little evidence, however, of coordinated metabolic activity in the embryo as a whole, i.e. over and above the metabolic activities of the cells.

Smith and Brogaard (2003) identify gastrulation (f) as the threshold that marks the beginning of human life. Gastrulation is an important milestone in multicellular development. Three important things happen at this point: the embryo “ceases to be a cluster of homogeneous cells and is transformed into a single heterogeneous entity”, with a bilaterian morphology; it has a bona fide spatial boundary; and it has a degree of integration such that twinning is no longer possible (Smith & Brogaard 2003: 62-63). However, at this stage the embryo is still unable to “regulate physiological homeostasis globally or autonomously” (Brown 2019: 1039); in the absence of a vascular system or global information channel, metabolic and developmental processes “function as independent sub-systems” (1039). For this reason, the post-implantation embryo is still a mere organic aggregate, rather than an integrated multicellular organism.

Brown (2019) identifies the development of a fully functional cardiovascular system (around 9 weeks post-fertilisation) as the beginning of organismal life, though a primordial circulatory system with some integrative function is present somewhat earlier (around 4 weeks post-fertilisation). Regardless of the specific developmental details, there is a lot to be said for the role of circulatory systems in the coordination of metabolism and other life processes in multicellular organisms. The circulatory system conveys nutrients and oxygen to the cells and removes waste, functioning as a life-support system for the cells that compose the organism, and also conveys information to cells in the form of chemical signals. In the developing foetus, the circulatory system functions "both as the transport system that enables cellular metabolism in the fetal body and as the carrier of signal molecules that integrate the coordinated development of other tissue and organ systems" (Brown 2019: 1040). It should be noted, however, that circulatory systems are only required in multicellular organisms that are too large for simple diffusion. Thus, the lack of a circulatory system, per se, may not necessarily be indicative of the absence of multicellular coordination. Thus the possibility that organismal life begins earlier, during embryonic development, rather than at the onset of foetal development, remains open.

On the other hand, some people might argue that the circulatory system is necessary, but not sufficient, for the coordination of life processes in highly complex multicellular organisms, for which a functioning nervous system is also required. This would mean that multicellular organismal life in humans begins at least after day 40 post-fertilisation, when the brainstem is formed (since the brainstem has important regulatory functions in vertebrates), but probably much later, since the developing nervous system does not immediately assume its regulatory functions. Electrical activity in the brainstem has been observed from 10 weeks gestation (Tawia 1992: 156) which, like Brown's cardiovascular criterion, roughly corresponds to the transition from embryo to foetus, but it is unclear whether this corresponds to the onset of coordination of life processes by the central nervous system.

A related hypothesis that also deserves consideration is the view that, for organisms whose life processes are coordinated by a central nervous system, *minimal sentience* is required for organismal integration. An indication that this might be the case is that ancient regions in the vertebrate hindbrain, especially the brainstem, seem to be involved both in homeostatic regulation, and in the production of representations of the state of the organism felt as basic emotions such as hunger, thirst, fear, pain, and pleasure (Denton 2005; Damasio 2010). On this view, human beings and other vertebrates would also begin to exist at the onset of coordination of life processes by the CNS, but this coordination would also involve sentience. It is important to note, however, that this view should be accepted, if at all, on ontological rather than ethical grounds. The role, if any, of sentience in the coordination of life processes of sentient organisms would be a reason for considering it a threshold of integration marking the beginning of organismal life, whereas the importance or moral value than we attribute to sentience would not.[104]

When discussing the beginning of the life of multicellular organisms, van Inwagen (1990) constrains the scope of possibilities in the following way: the activities of "cells arranged embryonically" begin to constitute a life "[c]ertainly not earlier than the inception of cell differentiation", and "[c]ertainly not later than the development of a functioning central nervous system, which, in the case of human beings, takes place about twenty four days after conception" (154). I broadly agree, although I would constrain the possibilities slightly differently. The life of a multicellular organism begins no earlier than the inception of global coordination of metabolic activity, and certainly no later than the development of a fully functional central nervous system which actively coordinates the life processes of the organism.

Although birth marks a momentous change for the physiology of the newborn organism, I reject the view that the life of eutherian mammals begins at birth (Kingma 2018, 2019, 2020), because the organism already coordinates metabolic activities at the multicellular level of biological organisation prior to birth. The foetus is a living object separated from the maternal organism by a semi-permeable boundary, and it coordinates its own life processes, despite being dependent on the maternal organism for its metabolic needs (which is also the case for parasites). Nevertheless, although the multicellular organism begins to exist at some point during development and is therefore, in viviparous organisms, contained within and physically connected to the maternal organism during its development, on the living objects view it is both an organism in its own right, and also part of the maternal organism.[105]

5.4. Aggregation and disaggregation

Aggregation and development are two distinct ways in which a composite organism might be 'constructed' out of simpler organisms. Aggregation is found mainly in more primitive cases of multicellularity, which are generally associated with higher cellular autonomy. Most cases of

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[104] Ethical questions should be kept separate from ontological ones (though they can be informed by ontology). For example, it is not inconsistent to hold that human organisms begin to exist when they acquire a functioning circulatory system, but also to maintain that they only acquire moral status once they become sentient.

[105] See Chapter 3.

aggregation are cases of aggregative multicellularity (Herron et al. 2022), such as the formation of a multicellular 'slug' composed of unrelated amoebae in slime moulds (Bonner 2009), whereas development is characteristic of clonal multicellularity (Herron et al. 2022). However, aggregation can also follow disaggregation of a multicellular organism originally generated through multicellular development, for example in some sponges (Porifera) and *Hydra* (Cnidaria). Some organisms composed of symbiotic partnerships that are re-established rather than inherited may also be considered cases of aggregation.

Although sponges are less complex than most other animals, they are multicellular organisms (as opposed to cell colonies), that exhibit several coordination systems at the multicellular level of organisation (Pavans de Ceccatty 1974). If a sponge is disaggregated into its component cells, however, the cells are able to spontaneously re-aggregate into a living organism. This raises the question of whether the sponge generated by the aggregation process is numerically identical with the pre-disaggregation sponge. Here the account of organismal persistence developed in chapter 4 provides a clear answer: it is not. Disaggregation is a form of death for composite organisms. The original sponge ceased to be a living object – the bound states among its cells were dissolved, even as the cells continued their individual lives – therefore, the organism did not persist. The second sponge comes into existence when *it* becomes a living object, i.e. when a new chain of bound states acquires the capacity to engage in and coordinate life processes at the multicellular level of organisation.

Interestingly, the sponge cells can sort themselves out into their appropriate places to some extent, though not necessarily in a way that exactly replicates the original arrangement of the pre-disaggregated sponge (Sendova-Franks & Franks 1999). But even if they did replicate exactly the same arrangement, that would still not make the new sponge numerically identical with the original sponge, since the original sponge ceased to exist when it disaggregated. Their histories are also different: the first sponge came into existence through multicellular development which included a motile larval stage; the second sponge came into existence through aggregation.

Understanding aggregation and disaggregation as processes whereby composite organisms can come into existence and cease to exist is also helpful for making sense of cases which otherwise seem extremely puzzling.

Jay Rosenberg (1983) and Feldman (1992) hold that, in typical cases of fission and fusion, organisms cease to exist without dying – they take a 'deathless exit' from life (Feldman 1992: 66). Luper (2022) argues that there is no such thing as a 'deathless exit', because "if something is an organism when it stops existing it must die" (116). Yet there is an important difference between death and ceasing to exist in one of these ways, for example through fission: in the case of death, the life processes of the organism stop irreversibly; hence the term ‘death’ is appropriate. In contrast, when a cell divides, its life processes do not terminate – they continue seamlessly in the descendant cells. For this reason, it is inappropriate to speak of ‘death’, since there is no termination of life processes, even though an organism ceases to exist.

Suppose, then, that in normal cases of fission and fusion organisms cease to exist without dying. Feldman (1992) argues that there are other cases of fission “that mimic deathless fission but that seem to involve the death of the divided organism” (69). He discusses the following thought experiment:

> “Imagine a device for use in biology laboratories – a “cell separator”. This is a machine that grinds up mice and then emits a puree of mouse cells. The machine is constructed in such a way that all the mouse cells come out alive. Each cell can be placed in a suitable medium and kept alive indefinitely.” (Feldman 1992: 69)

If a mouse is placed into this device, it goes out of existence, and therefore ceases to be alive. However, since the mouse “turns into a bunch of living things” (69), it would follow that if living things do not die when they undergo fission, then the mouse does not die when it undergoes cell separation. But it does seem that the mouse dies in this case. Feldman (1992) cannot explain the difference between the two kinds of fission.

The explanation is that the mouse does not “turn into a bunch of living things” at all. The living things were there all along; they are the cells that formerly composed the mouse and now do not collectively compose anything. There is no new organism generated in this process. What the cell separator does is *disaggregate* the mouse into its component cells – a process which inevitably kills the mouse, since it destroys the chain of bound states formed by the cells, along with its capacity to engage in and coordinate life processes. This is exactly what happens in the actual case of sponge disaggregation.

Another puzzling case of alleged ‘deathless exit’ is the case of complete metamorphosis in insects. Rosenberg (1983) and Feldman (1992) consider that the caterpillar ceases to exist upon metamorphosis, and a new entity, the butterfly, comes into existence. In contrast, Luper (2022) thinks that the caterpillar does not go out of existence at all; it merely “reshapes itself, and eventually continues its existence and its life in the form of a butterfly” (118).

Whether or not the caterpillar ceases to exist turns, I believe, on the minute details of what happens in the pupal stage. In holometabolous insects, most of the larval tissues undergo programmed cell death, and new organs develop from the imaginal discs (Buszczak & Segraves 2000). However, it is unclear (to me, anyway) whether this amounts to the complete disaggregation of the multicellular organism, or whether the coordinating activity of the imaginal discs is sufficient for the cell collective to engage in and coordinate life processes at the multicellular level of organisation. If the former, then the caterpillar ceases to exist through disaggregation and is replaced by a numerically different organism that originates through a second round of multicellular development within the same life cycle. If the latter, then caterpillar and butterfly are one and the same organism despite the extensive reorganisation that takes place during metamorphosis.

Luper (2022) also discusses metamorphosis in the context of "disassembly" into component cells. He suggests the following thought experiment:

> "Suppose [there was a] species of hydra each member of which went through a stage in which it *dismantled itself down to the cellular level*, then reassembled those cells in the shape of a small starfish. *Assuming that these cells remain bonded throughout*, integratism implies that the (organism that is a) hydra would remain in existence throughout this stage, and end up a starfish-shaped hydra. What happens would be a form of metamorphosis comparable to that of monarchs and many other insects." (Luper 2022: 118, emphasis added)

But Luper cannot have it both ways. Either the hydra dismantles itself down to the cellular level, in which case it dies through the process of disaggregation; or the cells remain bonded throughout, in which case the hydra could indeed persist, but in this case it did not dismantle itself down to the cellular level.

In the case of insect metamorphosis, the situation is even more radical, in that *most of the cells* die in the process. But it is unclear whether that amounts to the loss of more than 50% of the structures essential for life, or whether the imaginal discs are the indispensable structures at this stage. Evidence seems to point to the latter, in which case insects do survive metamorphosis.

5.5. Conclusion

If organisms are living material objects, they can come into being either as a result of processes of fission or fusion that produce new organisms while continuing the life processes of previously existing organisms; or they can come into existence through a composite object partly made of living objects itself acquiring the property ‘life’ at a higher level of biological organisation. This is the case in multicellular aggregation, multicellular development, and development in colonial organisms such as siphonophores. Organisms can correspondingly cease to exist deathlessly, through fission or fusion, or by dying, whereby the capacity of an organism to engage in and coordinate metabolic activities and other life processes is irreversibly lost. This can involve the complete loss of life processes or, in composite organisms, the loss of the capacity of the composite organism to engage in life processes, despite the continuation of life processes of some of its components. In the next chapter, I defend the view that organisms cease to exist when they die.

CHAPTER 6

Death and Suspended Animation

If organisms are essentially living objects, then one of the ways in which they can cease to exist is by losing the property ‘life’. This chapter discusses the nature of death and the phenomenon of cryptobiosis or suspended animation. §6.1 defines death as the complete and irreversible cessation of an organism’s capacity to engage in and coordinate metabolic activities, and discusses the death of simple and composite organisms. §6.2 argues that the living objects view implies the truth of the termination thesis, which says that organisms cease to exist when they die, and addresses several objections to it. §6.3 argues that it is not possible for an organism to die and later come back to life. The following sections discuss cryptobiosis. Many organisms have the capacity to cease their metabolism completely when frozen or dehydrated; I argue that these organisms are alive, (§6.4), and that the existence of temporarily ametabolic organisms supports the living objects view (§6.5). §6.6 concludes the chapter.

6.1. Radical discontinuity: death

Death is the complete and irreversible cessation of an organism’s capacity to engage in and coordinate metabolic activities. The organism ceases to coordinate its own life processes, and the life processes themselves cease. Here is how Olson describes it:

> “most biologists would agree that [death] has something to do with the irreversible cessation of those metabolic and other activities that distinguish living organisms from non-living things. Roughly, an organism dies when its life-sustaining functions cease and cannot be restored, or when its capacity to regulate those functions is destroyed” (Olson 1997a: 119).

Death might not be instantaneous (probably in most cases it is not); rather it is the endpoint of the loss of capacity of the organism to continue carrying out its homeostatic life processes, which results in an irreversible change from a far-from-thermodynamic-equilibrium dynamic system into an inert object fully at thermodynamic equilibrium. The dynamic stability of the living organism is irreversibly lost, and in its place thermodynamic stability is eventually reached.

Simple organisms such as bacteria are paradigm individuals: they are living beings that are entirely composed of parts which are not themselves alive. The death of a bacterium is, then, a relatively straightforward affair: it involves the complete and irreversible cessation of the organism's capacity to engage in any metabolic or any other life processes. For composite organisms, there is more than one life to take into account: there is the life of the composite organism, and the lives of its constituent living parts. Therefore, it makes sense to talk about multiple deaths.

The death of one or a few cells makes little difference to the life of a large multicellular organism. In fact, many of our cells are replaced frequently; for instance, cells in the lining of the stomach have a high turnover due to the acidity of their environment. Evidently, if a sufficiently high number of cells die, the multicellular organism cannot survive either. But as the multicellular organism has a life of its own, it is possible for it to die while some of its cells are still alive. Of course, being part of a multicellular organism, the cells rely on the adequate functioning of the whole organism for their own survival, so are unable to survive on their own for long. But it is possible to dissociate living cells from the tissues of multicellular organisms and keep them alive in culture (Alberts et al. 2002).

Cells can also be extracted from a multicellular organism in bulk, in the case of transplants. A liver that is kept 'alive' long enough for viable transplantation is not literally alive; the liver is not an organism, does not coordinate its own life processes, and does not have a life of its own. It is, however, composed of living cells. For an organ to be viable for transplant, it is essential that a sufficient number of these cells are kept alive before the organ is introduced and properly connected to the transplant recipient. For the liver cells that survive this adventure, and assuming the liver is not rejected, life continues – now as a functioning part of a different multicellular organism.

In colonial animals, too, there is death at more than one level, with researchers contrasting "partial mortality", which is the death of individual zooids, with "whole-colony mortality", which is the death of the colony (e.g. Denley & Metaxas 2016). While in some cases, whole-colony mortality can result from the death of all the individual zooids, this is not necessarily so. In many colonial organisms, the death of some zooids (for example, through "partial predation") may result in a "rejuvenilisation" of the colony as a whole (Rinkevich 2017). Some colonial organisms, such as

Botryllid ascidians, actively promote the periodic (sometimes weekly) death of the older generation of zooids, while having long, sometimes indeterminate life spans at the colony-level (Rinkevich 2017). In contrast, some colonies can exhibit a “programmed life span”, with the colony at some point generating a senescence signal which results in the death of the whole colony. So the death of the colonial organism and the death of its zooids are clearly distinct phenomena (as is the death of the cells that compose the zooids).

6.2. The termination thesis: there are no dead organisms

If organisms are essentially living objects, it follows that they cease to exist when they die. The view that organisms cease to exist when they die has been termed the ‘termination thesis’ by Feldman, who opposes the view. If organisms cease to exist when they die, then there is no such thing as a ‘dead organism’; after the organism dies, what we are left with are merely its remains. While we might call something a ‘dead animal’, “strictly speaking what is lying there are only the lifeless remains of an animal that no longer exists” (Olson 1997a: 136). Olson (1997a) acknowledges that saying that a dead animal is not an animal may seem paradoxical or even absurd, but then “a ghost town is not a town, a dry lake is not a lake, a tin soldier is not a soldier, and a dead person is not a person” (136).

Historically, Aristotle, Epicurus, Aquinas, and Locke are among the philosophers who have defended the termination thesis. While defending the opposite view, Snowdon (2014) admits that “[i]t needs registering immediately that the proposition that an animal ceases to exist at death seems to many people a fairly obvious true one” (117). At the other extreme, David Mackie thinks that the termination thesis “strongly conflicts with what ordinary people believe” and is obviously false (1999: 234). Such a clash of intuitions is unlikely to prove illuminating, so it is better to examine the various arguments. In this section, I aim to show that the arguments against the termination thesis are ultimately unconvincing.

The main objections to the termination thesis are the following: (1) commonsense intuitions and/or ordinary linguistic practices support the idea that there are dead organisms; (2) we can obtain knowledge from corpses which is hard to explain if those bodies were not once alive; (3) biological descriptions in ecology seem to encompass both living and dead organisms; (4) artefacts such as watches do not go out of existence when they are irreparably broken, so why should organisms?; and (5) in most cases, there remains a corpse after the organism has died; if the corpse is numerically different from the living organism, then where does it come from? The termination thesis seems to suggest it pops into existence out of nowhere. I address each of these in turn. A further objection (6) concerns the possibility of reviving dead organisms, which is discussed in §6.3.

6.2.1. Common sense and ordinary language

Although the view that organisms cease to exist when they die would seem to be quite intuitive, several philosophers are of the opinion that it clashes with common sense, because ordinary people say things like "this animal is alive, but that animal is dead", or "I have a dead butterfly in a box" (Snowdon 2014: 115). For instance, Feldman (1992) insists that the standard or commonsense view is that there are dead organisms, and that ordinary language supports this. He discusses Rosenberg's example "Aunt Ethel died last week, and we're burying her tomorrow" (Rosenberg 1983: 27) as evidence that the way we habitually speak commits us to the idea that one and the same thing was alive and is now dead (Feldman 1992: 92-94). Rosenberg, on the other hand, sees this as mere linguistic appearance. What we are burying tomorrow is Aunt Ethel's corpse, which is not a person. In fact, he explains, "in our customary speech, the expression 'dead person' is ambiguous, because it picks out either a corpse – which is not a person at all – or a person who has died" (Rosenberg 1983: 28), even when there are no longer any material remains of that person. So even if saying that someone is dead does not imply that they do not exist, neither does it imply that they exist (Snowdon 2014: 116).

Judith Jarvis Thomson (1997) considers it to be obviously true that there are dead animals; the case of persons is the only one which is doubtful: "[c]ats who die in bed become dead cats at the time of their deaths; why should it be thought otherwise in the case of people? Can't there be some dead people as well as some dead cats in a house after the roof falls in?" (202). Mackie (1999) agrees that "it is only when it comes to people, of persons, that we are at all inclined to hesitate", whereas "most people regard it as obviously true that dead grass is grass, and that dead butterflies are butterflies" (223).

Feldman (1992) gives the example of a restaurant which claims to serve fish so fresh that "the fish you eat today, last night slept in Chesapeake Bay" (95). Does this slogan support the claim that one and the same thing was alive yesterday and is dead today? We might say that we are eating *the very same fish* that was caught yesterday, but what does this show? Not much, I think, beyond linguistic accident. In English, we might say we are eating beef, which seems more removed from the actual animal, whereas other languages have no separate words for beef and cow. For fish, there is no such separation of terms between what is eaten and the living animal. None of these linguistic facts seem to illuminate any deep metaphysical issues. At most, they might shed some light on human psychology, since no one would care to describe their gastronomic experience as having eaten a delicious “fish corpse”, regardless of how accurate that statement might be.

While sometimes people will speak in ways which seem to contradict the termination thesis, other times they say things that seem to agree with it; for instance, they will say things like “Aunt Ethel is gone”, and will agree that she is not present (Hershenov 2005: 38). They might also, at the funeral, express regret at not having seen their relative one last time, which implies that it is not their relative that they are seeing in the coffin, but merely a corpse. Those who believe that people exist after death usually think they are in Heaven or that they live on in our memories; they don’t think they exist as a corpse.

Many things that people say about death are not to be taken literally, as they are often things meant to comfort, and not to be taken as metaphysical truths. For instance, a statement like “Just as he wished, he was scattered all over a beautiful meadow after he died” (Johansson 2005: 49) is not meant to be literally true. Snowdon (2014) also mentions the profoundly disturbing case of parents whose children have died violent deaths, who desperately try to prevent the corpse from being buried or cremated “*so they can still see their child*” (115). But this deeply emotional attitude should not be seen as an endorsement of a particular metaphysical view; in fact, the child’s clothes or toys might be the target of an equally desperate attachment on the part of the bereaved parents.

On the other hand, people do speak of death explicitly as ceasing to exist, at least in more formal contexts. Consider this excerpt from a speech made by a prisoner sentenced to death in 1803, shortly before his execution:

> “Your executioner may abridge the period of my existence, but while I exist I shall not forbear to vindicate my character and motives from your aspersions” (Emmet 1803).

6.2.2. Obtaining knowledge from the corpse

Several opponents of the termination thesis are impressed by the fact that butterfly collectors collect butterflies. Feldman, for example, objects to Perrett’s (1987) characterisation of death as the *destruction*, *annihilation* or *disintegration* of an organism on the grounds that, if a butterfly collector captures a butterfly and places it carefully in a jar so that no damage is done to the specimen, what she has at the end is a perfect, albeit dead, butterfly specimen (Feldman 1992: 59). Mackie (1999) uses Feldman's example of the dead butterflies to argue for a slightly different thesis, namely that butterfly corpses are "members of the biological kind *butterfly*" (234):

> "These corpses owe every feature they have – their physical structure, chemical composition, and so on – to the fact that they are products of biological processes distinctive of the biological species in question. It is reasonable to suggest that it is precisely because these are butterflies that it is possible to learn about butterflies by studying such collections" (Mackie 1999: 234).

Snowdon (2014) also uses the butterfly example to argue that "we give evidence, in our predicative practice, of thinking that the living entity is the same thing as the dead thing. I might say, for example, 'this (dead) butterfly was caught four days ago'" (119). Another of Feldman's examples is that children in an elementary biology class dissect dead frogs, and it would be exceedingly strange to say that what they are examining is an object that never lived. But that is what the termination thesis forces us to say: "The former frogs would have gone out of existence when they died. The items being dissected by the children must have come into existence approximately when the frogs departed" (Feldman 1992: 94).

If the corpse is not the animal, how can we have collections of dead butterflies, learn about frog anatomy by dissecting dead frogs, and infer the cause of death from the careful observation of a human corpse? The reason we can do these things is, of course, that the structure – at least, the gross macroscopic structure – of the animal corpses observed stems from the fact that "they are products of biological processes distinctive of the biological species in question", just like Mackie says (1999: 234). But must 'dead butterflies' *be* butterflies, or 'dead frogs' frogs, in order for us to learn about the anatomy of the living animals they are the remains of?

For one thing, it is simply not true that we can only learn about a species from observing individual organisms of that species. We can learn about organisms from a wide variety of sources, such as "footprints, artefacts, nests, feather, stools, and blood samples of the species in question" (Hershenov 2005: 453). Much of our knowledge of extinct species comes from fossils, which preserve to a large extent the gross anatomy of the living organism, even though they can be entirely composed of minerals. Sometimes only one or a few fossilised bones remain; other times nothing remains of the original organism but a mould or cast has been preserved, which still allows us to visualise its structure. We can also learn about extinct organisms from ichnofossils, such as fossilised footprints. Evidently, we can also learn about organisms from photographs, drawings, plastic models, etc. None of these things are the organism, but neither is it in the least puzzling how we can obtain knowledge from them.

But even when considering dead '*specimens*', is it problematic to say that they belong to the same biological species as the living organism? Feldman (1992)n sees no reason "to suppose that biological organisms lose their species membership merely by dying" (104). He is also inclined to believe that "it is practically impossible for something to be *human* if it is never alive" (118). But there is a difference between being human and being *a* human. Is a human corpse human? Yes. But it is not a human being. (Or: is a feline corpse feline? Definitely. But it is not a cat; it's the remains of a cat.) Plenty of things are human which were never alive: a human DNA molecule in the lab or a human DNA sequence in a computer database, human artefacts, human cave paintings, human language, etc. The same goes for other species: a bird's nest, spider's web, and other animal artefacts can be classified taxonomically, yet those objects were never alive. A bird's nest may even serve as the type specimen for a species of bird (Ghiselin 1997: 67). None of this requires that the classified biological object must be *an individual organism* of that species.

6.2.3. Naturalness and scientific terminology

Rina Tzinman (2018) raises a new objection to the termination thesis, albeit related to the previous one.[106] She claims that 'organism' is used in biology to mean a single category of things which can be either living or dead – 'somatic organisms'. Since 'organism' is such an important notion in biology, if true, this would indeed be surprising news, since everyone, not least biologists, is under the impression that biology is the science that studies the *living* world.[107]

Tzinman (2018) focuses on some scientific papers describing a parasitic fungus which infects ants, causing them to "climb up the foliage and clamp onto the underside of a leaf", where they are killed by the fungus (4089). Because the scientists describe the fungus as spouting a stalk

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[106] Although her main target in the paper is corpse eliminativism rather than the termination thesis *per se*.

[107] Dictionary definitions of 'biology' seem to agree on this point: "Biology is the science which is concerned with the study of living things" (Collins 2023); "the scientific study of the life and structure of plants and animals" (Oxford University Press 2023); "a branch of knowledge that deals with living organisms and vital processes" (Merriam-Webster 2023). While dictionary definitions cannot be expected to settle philosophical disputes, they do provide a good perspective on the ordinary meaning of words, shifting the burden of proof onto those who propose to radically redefine existing concepts.

from the back of the dead ant's head, and seemingly "quantify over dead organisms", correlating several parameters with the number or density of dead ants, Tzinman (2018) sees this as evidence that the scientists share the assumption that "the dead ant is the same ant that was infected and manipulated by the fungus" (4091). She concludes that "[t]he (simplest) assumption seems to be that the fungus is manipulating one object throughout", and that ants – both alive and dead – form a category "because of their causal role in phenomena for which it is important that they are organisms with certain structural features, but not important that they are alive" (4091).

The fact that some scientists studying ant/fungal ecological relationships talk about "dead ants" should not carry more weight than the fact that ordinary speakers do too. This is the objection from ordinary language all over again: while the scientist is speaking in a professional capacity, she is not doing metaphysics, and 'dead ant' is perfectly adequate, if slightly less rigorous, terminology for what is technically an ant corpse. In fact, not only is nothing lost in these papers' accounts if all instances of "dead ants" are replaced with "ant corpses"; it is also not hard to find countless other papers that do refer to ant corpses. For instance, in the same context – ecological relationships between ants and fungi – Rodrigues et al. (2010) speak of "[a]nt corpses showing signs of contamination by insect pathogenic fungi", and explicitly quantify over "corpses" (342), not 'dead ants'; Kesäniemi et al. (2019) similarly refer to "fungi growing on Argentine ant corpses", and found that the ants perform "corpse management" behaviours that tend to inhibit the growth of pathogenic fungi. Therefore, it is misleading to read anything more into talk of 'dead ants' than a stylistic option.

Another point on which Tzinman's (2018) argument relies is the fact that the structure of the ant is causally important in the process, but not whether it is dead or alive. Certainly, Tzinman has identified one of the very few things that both living organisms and corpses can do – serve as food or substrate for the growth of other organisms. This is hardly a good reason to abandon the view that organisms are essentially living, much less to argue, as Tzinman (2018) proposes to do, that somaticism "has the upper hand in terms of simplicity" when, if somaticism were true, almost all generalisations in biology would have to be preceded with a disclaimer that the generalisation concerns *living* organisms, as she herself admits: "somaticists can easily introduce a restriction to the effect that generalizations about migration trends and behaviors concern *living* birds" (4092). Nevertheless, even in the case of the fungus and the ant, it is not true that it makes no difference to the fungus whether the ant is dead or alive. On the contrary, ant corpses cannot be infected, since they are unable to climb up foliage or bite into it; the fungus can only infect *living* ants (which then die, a fact which is, admittedly, of no importance to the fungus).

Concerning whether the assumption that the fungus is manipulating the same object throughout is the “simplest” assumption, it is unclear why this conclusion should be thought to follow from the description of the facts. Suppose a chemist is manipulating some chemical substance in such a way that it turns into a different chemical substance, upon which she continues to manipulate it. Is assuming that she is manipulating the same chemical substance throughout the simplest, or even a plausible assumption? Certainly not. And neither does the importance, or lack thereof, of the chemical reaction from the point of view of the chemist matter for deciding whether the chemical substance is the same or different.

6.2.4. Life, structure, and the broken watch objection

Mackie (1999) considers one of the reasons why many philosophers defend the termination thesis to be their assent to Locke’s distinction between the persistence conditions of masses of matter and living beings. Locke defended the view that the identity of a living being essentially involves the continuation of its life, and does not depend on the permanence of its matter, which is constantly changing (Locke 1689/1997: II.xxvii.3) However, Mackie (1999) claims that it is possible to maintain Locke’s distinction without requiring the organisms to actually be alive; instead, he suggests that “the persistence of biological organisms depends on their retaining (enough of) organisation of parts that is the product of their natural biological development, and that makes them apt for life, while stopping short of saying that life itself is necessary” (236). He argues that if, according to Locke, a plant continues to exist while its parts are organised in such as way “which is fit to convey that Common Life to all the Parts so united” (Locke 1689/1997: II.xxvii.4), it might be possible to meet this requirement while stopping short of demanding that actual life be present:

> “the parts of an organism plainly can be organised in such a way that they are *fit to* convey life to the organism, even if they are not actually doing so. Freshly dead trees, butterflies and human beings may retain an almost perfectly intact organisation of their parts” (Mackie 1999: 237).

Therefore, Mackie (1999) proposes that organisms are not necessarily alive, but persist “as long as this organisation of constituent parts remains sufficiently nearly intact” (237). Evidently, he cannot mean that the organisation remains *exactly* as it was just prior to death, because if it were so, the organism would in fact still be alive. What could possibly prevent it from being alive in those circumstances? The organism is not a material ‘vessel’ coupled with a mysterious property, life, which can vanish at any moment leaving behind a lifeless material object exactly like the living one. Rather, for an organism to instantiate the property ‘life’ it must have a suitable physical structure, which it actively maintains through its own metabolic activities. This structure is both necessary for, and a result of, those activities. Life ends when the physical structures that allow the organism to maintain these vital activities are irreversibly damaged, which usually happens first at a microscopic scale, before it is macroscopically perceptible.

It is simply not possible for there to be an organism whose parts are “organised in such a way that they are *fit to* convey life to the organism, even if they are not actually doing so”. If the parts were fit to convey life to the organism, the organism would indeed be alive. What could possibly prevent it from being alive, if it had a physical structure that made it fit for life, i.e., that conferred it the capacity to engage in life processes? The corpse does not in fact have the same physical structure as the living organism – it only appears to. At (macroscopic) first sight it may seem to have *a large amount* of the original physical structure, but at the cellular level this structure is too degraded to preserve the capacity to instantiate any life processes.

But Mackie (1999) does not exactly claim that “complete, or even very nearly complete, intactness is required”; instead, he argues, it is not necessary for the persistence of an organism such as a human being “that it actually be *apt* for life, if that is understood as meaning that it would have to be so perfectly intact that it might in principle be revivable” (241). This is important, because a supporter of the termination thesis might agree with Mackie if what he meant was that the organism was so intact that it could still in principle be revived. If an organism is so perfectly intact in its organisation, even at the cellular level, that it could still be revived, then it is not, in fact, dead, although it might be on its way to dying very shortly, unless it is either quickly revived, or somehow preserved in its present state.

But, if complete intactness or actually being apt for life is not what is required, then how intact must the supposed organism be? Sufficiently intact that we can visually recognise it as belonging to a certain species? This raises the problem that we might still be able to identify even very degraded remains to the species level. Sufficiently intact that we might mistake it for a motionless living organism? But surely we cannot draw metaphysical conclusions from mere appearance. What exactly should be the criterion? David Hershenov (2005) thinks “there lurks here a real danger of ‘perceptual intuition mongering’”; what is sufficient structure might depend on the purposes of the identification (do we want to know who the individual was, or merely identify the species?) as well as the expertise of the observer – “[w]hat is enough structure for the coroner, forensic scientist or physical anthropologist might not appear to be so for the layperson” (453).

Mackie also suggests that Locke's analogy with a watch can be used as an argument against the termination thesis. The idea is the following: if a broken watch does not go out of existence when it its ability to function ceases, why is this not the case with organisms? Here is Locke's comparison between organisms (animals) and machines (in this case, a watch):

> "[W]hat is a watch? It is plain it is nothing but a fit organization or construction of parts to a certain end, which, when a sufficient force is added to it, it is capable to attain. If we would suppose this machine one continued body, all whose organized parts were repaired, increased, or diminished by a constant addition or separation of insensible parts, with one common life, we should have something very much like the body of an animal; with this difference, That, in an animal the fitness of the organization, and the motion wherein life consists, begin together, the motion coming from within; but in machines the force coming sensibly from without, is often away when the organ is in order, and well fitted to receive it." (Locke 1689/1997: II.xxvii.5).

It seems to me that Locke is simultaneously comparing the functioning of an organism with the functioning of a watch, and also highlighting an important difference between the two: namely, in the case of the organism, both the organisation of parts, and the life process itself, come from within, whereas in the case of machines it comes from without. An organism "is responsible for the unity of its own parts. It has the internal causal power to maintain as well as replace its parts" (Hershenov 2005: 453), a capacity that is conferred by its physical structure. An artefact lacks this capacity. Therefore, the fact that watches continue to exist when they stop functioning has no bearing on the question of whether organisms cease to exist when they die.

6.2.5. Where does the corpse come from?

An advantage of animalism over psychological persistence views is that it avoids the problem of spatially coincident entities, whereas personalists need to countenance the existence of two separate, but spatially coincident entities – the person and the animal it is "associated" with. However, some personalists have countered that animalism also faces a comparable problem of spatially coincident entities, namely the body and the organism, as it seems that, while the organism ceases to exist at death, the body outlasts the organism, continuing to exist after death (Shoemaker 1999a, 1999b; Baker 2000; see discussion in Olson 2004).[108]

The concept of "body" is notoriously muddled (Long 1964; van Inwagen 1980; Olson 1997a: 142-153). Rosenberg lists five different concepts of 'body': (1) a physical object; (2) the trunk or central part of the animal, as opposed to the head and the limbs (it might also be said of a tree, as in "the trunk is the main body of the tree"); (3) the shell or container of the vital organs (which a surgeon for instance might use to distinguish from the organs that go inside it); (4) a corpse; and (5) a living animal or person, usually with a view to highlighting its physical aspects (Rosenberg 1983: 47-48). In this latter sense, it might seem reasonable to claim that the body is something distinct from the living animal or person, because it seems absurd to say, for example, that "[m]y body read a novel last week", or "my body played a game of chess yesterday" (Olson 1997a: 152) or even "the cat's body jumped over the fence". The supposed absurdity of these sentences stems from the fact that mentioning the body carries the pragmatic implication that the sentence is about a physical property, an unconscious, or an involuntary action (Olson 1997a: 152-153).

In any case, there is no good reason to claim the existence of a separate entity, the body, which is present both before and after death. Before death, the living body has no properties that are not the properties of the organism; therefore, it makes no sense to postulate its existence. The concept of 'living body' is in all details completely parasitic on the concept of organism. And, if the persistence conditions of organisms are such that they cease to exist upon death, it is not possible that corpses exist before death either; the two things have incompatible persistence conditions (Olson 2004). Any reason for thinking that organisms cease to exist when they die are equally good reasons for thinking that corpses come into existence at the same time.

Shoemaker compares Olson's suggestion that corpses come into existence at death with the view, criticised by Olson, that the foetus ceases to exist when it becomes a person: "Olson rightly ridicules the suggestion that the foetus goes out of existence when the person comes into existence. But it seems equally ridiculous to say that the corpse is something that comes into existence at death" (Shoemaker 1999b: 499). In contrast, Shoemaker (1999b) finds it plausible that prior to death there is a bodily entity, the "corpse-to-be", which shares its physical properties with the organism but is not identical with it (499-500); whereas I find this view extremely puzzling. By 'corpse-to-be', he cannot mean the living body, as that is simply identical with the living organism;

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[108] Árnadóttir (2011) argues that animalists can overcome the corpse problem by denying that bodies can think. Sauchelli (2017) thinks that animalists should adopt 'phase animalism' and consider 'animal' and 'corpse' to be different phase sortals for the same material object. Most other animalists opt for corpse eliminativism.

but the dead body does not exist yet either. It seems that Shoemaker means "the portion of matter, or collection of fundamental particles, of which the person is at that time composed", and which is "plainly not identical with the person, since the person is composed of different portions of stuff at different times" (500) – and this is true of the organism as well.[109] But it is far from clear that this portion of matter survives death. In fact, it is unclear that it survives even a single breath, since the living organism exchanges particles with the environment all the time. If, on the other hand, we allow that this portion of matter can change composition, then it is no longer the same collection of fundamental particles, nor is it clear any longer that what we are talking about is in any way distinct from the organism.

The idea that the body of the organism survives death seems to rely on a misconception of what happens at death. Although the corpse looks like the living organism, it is a different kind of object entirely. Its similarity to the organism is only apparent, and due to the fact that we are merely looking at its gross macroscopic structure:

> "The changes that go on in an animal when it dies are really quite dramatic. All of that frenetic, highly organized, and extremely complex biochemical activity that was going on throughout the organism comes to a rather sudden end, and the chemical machinery begins immediately to decay. If it looks like there is not all that much difference between a living animal and a fresh corpse, that is because the most striking changes take place at the microscopic level and below." (Olson 1997a: 151-152).

When the organism dies, its cellular structures are irreversibly destroyed, which may not be immediately evident to the naked eye, but is nevertheless a profound change. Corpses are not only numerically different objects from living beings; they are qualitatively different, too. In fact, if the corpse were exactly qualitatively identical to a living organism, down to the minute details of its molecular and atomic structure, it would not be a corpse, but a living organism. The main difference between the corpse and the organism is that the corpse lacks "the ability, capacity, or capability to preserve its intricate material organization through ongoing (physical, chemical) transactions with its environment" (Rosenberg 1983: 105). It lacks this capacity because its physical structure is irreversibly damaged and no longer allows the organism to engage in metabolic activities.

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[109] I assume that Shoemaker means a portion of matter arranged in a certain way, since if the collection of matter were to be pulverised, the fundamental particles would still exist, but they would not compose any object.

Eliminativists such as van Inwagen (1990) solve the problem in a radical way: they claim that there is no such thing as a corpse, but merely particles arranged in a certain way, which do not compose any object. The corpse is a mere plurality of things that does not compose any individual or substance (Hershenov 2005). But, although organisms are indeed ontologically distinct from other material objects, it is not necessary to deny the existence of all non-living material objects in order to uphold this distinction. On the contrary, the living objects view allows us to accept a naturalistic view of composition, the bound state view, which applies to both living and non-living objects, while at the same time maintaining that organisms have a distinct ontological nature and persistence conditions. Since the corpse differs from the living organism both in its physical structure and persistence conditions, there is no reason to accept the claim that the same object exists both before and after death.

However, after the death of the organism we are faced with a material object where the organism used to be, possibly only moments ago. If the corpse is not a material object that has survived the transition from life to death, where does it come from?

Rosenberg claims that death is a change of kind, comparable to radioactive decay (1983: 33). This analogy is apt. Consider the radioactive carbon isotope, carbon-14. Although relatively stable (it has a half-life of 5,700 years), the carbon-14 atom eventually decays into the more stable nitrogen-14, when one of its neutrons decays into a proton, emitting an electron and an electron antineutrino in the process (Chaichian et al. 2013: 283). Does the carbon atom still exist after this event? Certainly, there is an atom where the carbon atom used to be but, arguably, it is not the same atom. The two atoms belong to different elements. Before radioactive decay, there was a carbon atom, which has atomic number 6; afterwards, there is an atom of nitrogen, which has atomic number 7. The two atoms belong to different natural kinds. An atom of carbon has ceased to exist, and, at the same time, an atom of nitrogen was brought into existence.

Just as there is no deep mystery about where the nitrogen atom came from – it came into existence when the carbon atom decayed – there is no deep mystery about where the corpse came from: it came into existence when the organism died. The organism is a material object, and the matter that composes the organism immediately prior to death continues to exist after the death of the organism. However, this matter no longer composes an organism; it now composes an entirely different kind of object, a non-living chunk of organic matter roughly similar in shape and macroscopic appearance to the recently deceased organism.[110] In both cases, the new object is partly composed of the same matter as the previously existing object, yet it belongs to a different

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[110] In cases where there is a corpse. Evidently, if the organism is eaten, or dies in an explosion, the matter which composed it prior to death may now compose a multitude of smaller objects.

persistence kind. The organism persists through time in a dynamic manner, exchanging materials with its environment in an active pursuit of its own continued existence. The corpse, on the other hand, has the same metaphysical nature as a bar of soap or a loaf of bread. It persists through time in a thoroughly unremarkable, entropic manner.

6.3. Coming back to life

A familiar idea from modern medicine is that certain medical procedures can ‘resuscitate’ patients who have been dead for a short while. Survivors might report that they ‘were dead for 5 minutes’. This could not be further from the truth. As Rosenberg points out, “clinical death is not a kind of death” (1983: 58); it is only the reversible cessation of some vital signs, such as heartbeat and respiration. A ‘clinically dead’ patient is someone who will die very soon if their cardiac and respiratory functions do not resume shortly. The medical procedure of ‘resuscitation’ aims at restarting these vital functions of the organism *before* death occurs. In fact, medical guidelines on cardiac resuscitation explicitly state that, when called to the scene of cardiac arrest, medics should always perform resuscitation, “unless there are obvious signs of death” (Eisenberg & Mengert 2001).

While at room temperature cardiac arrest usually causes death within minutes, death might take considerably longer at lower temperatures, which explains why doctors were able to revive a woman who was in cardiac arrest for six hours while in hypothermia (BBC News 2019). Scientists are also developing new technologies of ‘suspended animation for later revival’, in which patients will be deliberately kept in a state of hypothermia while in cardiac arrest, with no blood circulation, while they are transported to the hospital (Safar &Tisherman 2002). Artificially reducing the metabolic rate of the organism prevents death from occurring in the normal time frame, ‘buying some time’ for doctors to intervene and reverse the damage, thus preserving the patient’s life.

Unless one adopts a definition of death whereby death occurs whenever certain vital functions are stopped and cannot be spontaneously restarted by the organism itself (Becker 1975; Cole 1992; Hershenov 2003), these are not cases of death. On the contrary, death is precisely the outcome that these medical interventions attempt to avoid. In fact, they do not involve suspended animation: even at low temperatures and in the absence of circulation, metabolism has not ceased at the cellular level, although it is significantly slower than normal.

In cryptobiosis (further discussed in §6.4), there is a complete suspension of metabolic activity. It is tempting to say that the organism has ceased to be alive. Jack Wilson (1999) says that a cryptobiotic animal "is clearly not alive, though it once was, which makes it dead" (102), but this does not seem quite right, because cryptobiosis is a state that organisms can *survive*. The life processes of the organism have not stopped irreversibly. For this reason, Feldman (1992: 62) concludes that 'ceasing to be alive' is insufficient as a definition of death. He considers the following qualifications: permanence, irreversibility, physical impossibility to live again, and physical impossibility to live again due to internal changes.

Permanence and irreversibility do not entirely solve the problem. Feldman (1992) discusses the hypothetical case of two twins that are frozen, but one of them suffers damage while in suspended animation, making it impossible to reanimate him. The other twin suffers no damage and is later revived. According to Feldman's interpretation, both twins cease to live when they are frozen, but this condition becomes permanent only for the twin who suffers the damage. Yet, intuitively, both twins are in the same state during the period of freezing. Adding an irreversibility requirement does not help, in Feldman's view, since this means that the twin whose body is damaged *never* dies, because when he ceases to be alive this condition is reversible; it's only later that it becomes irreversible.

On the view that organisms in suspended animation are alive, however, the case is much less puzzling, and there is no significant problem in identifying the moment of death. Both twins are alive when they enter suspended animation, even though their metabolism is then suspended. One of the twins survives; the other suffers lethal damage during suspended animation, causing him to lose viability. He therefore dies at that moment (see §6.4 below).

Another possible qualification is to require the physical impossibility of living again for death to occur (Feldman 1992). The problem with this is that physical impossibility might involve internal or external changes. For instance, reanimation might be impossible, not because the organism is not viable, but due to the body being unreachable, or due to the loss of technology necessary for reanimation. In Cody Gilmore's (2013: 20) thought experiment, a space-travelling tardigrade, Delta, is riding through deep space in a state of anhydrobiosis, when suddenly some stars around it explode into supernovas. This makes it physically impossible for the tardigrade to find favourable environmental conditions for rehydration before radiation from the supernovas renders it nonviable. Yet this physical impossibility is entirely external to the organism, which still has the capacity to resume metabolism, although it will not have the opportunity to do so. The problem is solved by considering only internal changes in the organism to be relevant, equating loss of viability with death.

Many philosophical discussions about suspended animation have focused on the question of technology. This is understandable since, as human beings do not have the natural capacity to enter cryptobiosis, both the induction of such a state and recovery from it would require technological intervention. There is a small cryogenics industry dedicated to storing frozen human beings in the hope that future technology might permit their revival. Since this technology does not yet exist, cryogenics procedures can only be initiated after the subject is legally dead. It is important, however, to distinguish the question of technology from the question of viability. At present, we cannot know whether any of the individuals stored are viable. We do not know whether current cryogenics procedures preserve cellular structure sufficient well, if they adequately prevent formation of intracellular ice crystals in a large multicellular organism, or even if the time it takes for the preservation products to diffuse through the tissues is fast enough to prevent massive cell death. Thus, we do not know if the objects currently stored in cryogenic facilities are human beings in suspended animation, or corpses which can never be revived, regardless of technological advances.

According to Hershenov (2003), death "should be determined solely by biological factors rather than technological features of the future." (93). Robert Francescotti (2018) also defends a principle 'E' that says that "whether an individual *x* exists at some time *t* depends only on the conditions that obtain up to and including *t*, not on conditions that obtain after *t*" (192). This principle seems sensible. In a situation of cardiac arrest, for example, whether or not resuscitation is carried out, if the organism is still viable, then it still exists. After a certain point, viability is irreversibly lost and actual death (not clinical death) occurs. Whether an object is a living organism or a corpse cannot depend on technology. It is entirely a matter of viability. But viable organisms that cannot restart their stopped vital processes do tend to die if no technology is available to revive them.

Some authors, however (Luper 2009; Gilmore 2013), suggest the far more radical possibility that organisms might be brought back from actual death. Here is Luper's thought experiment:

> "*The Corpse Reassembler*: I have a heart attack, and die. My corpse begins to decompose, but my nephew stows it away in a freezer. Centuries later, scientists thaw it and, using a device they call a Corpse Reassembler, return all of its atoms to where they were before I had my heart attack, thus restoring my life." (Luper 2009: 45).

Although Luper and Gilmore call cases like this 'restoration' or 'postmortem revitalisation', it does not seem substantially different from 'resurrection'. In fact, the freezing itself is not doing any work in this thought experiment. The important claim here is that in the future, doctors might be able to revive a corpse. It seems reasonable to expect that future technology will allow us to intervene later in the dying process – cardiopulmonary arrest used to not be survivable; now, thanks to technology, and a better understanding of human physiology, it sometimes is. But this cannot be expected to go on indefinitely. At some point, which we are unable to precisely specify, but which, for humans, might be less than an hour at room temperature and considerably longer at lower temperatures, the organism will no longer be viable.

If an organism is no longer viable, it is not possible to revive it. What Luper suggests is that future scientists might be able to revive a partially decomposed corpse by re-organising its atoms back to their positions prior to death. Gilmore (2013) says that "[w]ithout introducing any new matter or removing any of the original matter, the scientists gradually and nondisruptively reverse the damage that has recently occurred" (23). But surely, if it were possible to revive a slightly decomposed corpse by reshuffling its atoms, it would also be possible to revive a much more severely decomposed corpse by reshuffling its atoms. In fact, such a technology would also make it possible to reshuffle a suitable quantity of hydrogen, oxygen, carbon, etc., into a human being. None of these actions would result in reviving numerically the same organism as a previously existing one. At most, scientists would assemble a perfectly good replica of a formerly existing organism.

A similar discussion has already taken place in the form of the religious problem of resurrection, which early Christians believed was a *bodily resurrection*. The problem is essentially the same: if God were to collect the atoms that composed a human being and reassemble them back into the exact positions they occupied when the individual was alive, He would still not thereby bring back the very same organism. The problem, according to van Inwagen (1978), is that the chain of causality has been broken: the positions the atoms occupy in a living organism are due to the life processes of that organism; if, after the organism's death, the atoms are reshuffled back into their previous positions, whether by God or future scientists, the reason they now occupy those positions is due to a miracle, or to the actions of the scientists, and not to the life processes of the organism. Van Inwagen argues that "if a life has been disrupted, it can never begin again; any life that is going on after its disruption is not *that life*" (1990: 147), whereas if a life has merely been suspended, it can resume.

Gilmore (2013) does not find the claim that the resulting organism is a copy, and not the original organism, compelling, although he admits that someone who holds that the organism died, believes the termination thesis to be a necessary truth, and denies the possibility of intermittent existence, will want to accept it. Clearly, if it is not the case that the organism died, then the problem vanishes – the organism was presumably revived ‘in the nick of time’. Gilmore (2013) initially claims that the ‘restoration’ thought experiment is neutral as to whether the organism actually dies, cautiously stating that “at t_2, as a result of old age and standard wear and tear, it ceases to engage in metabolism and any other life-functions”, and furthermore the portion of matter that constituted the organism moments before then “begins to decompose slightly” (23). This seems to be a good indicator of death, but some organisms can survive suspension of their metabolism, and a small amount of decomposition can occur in a living organism (e.g. in a case of gangrene).

But in ‘restoration+’, Gilmore (2013) specifies that the organism actually dies, and the same organism is again alive at a later time. This, I claim, is not a real possibility. It might be difficult to determine the precise moment of death; it might even not be possible to determine this moment in principle, due to vagueness. But there are many moments *after* death when it is quite certain that an organism is dead, and dead organisms do not return to life. Gilmore (2007) admits that the possibility of postmortem revitalisation “is highly controversial at best” (224), but maintains that, other things being equal, it is better to have a definition of ‘death’ that is neutral with regards to substantive metaphysical questions, whereas I do not believe such neutrality is either achievable or desirable. In any case, to accept the possibility that an organism could die and later come back to life, one would have to either reject the termination thesis, or else accept the possibility of gappy existence. Neither is an attractive option.

6.4. Neither dead nor alive?

Corpses cannot be revived. But organisms can survive having their life processes suspended, sometimes for long periods of time. Many small invertebrate animals rely on cryptobiosis, pausing their metabolism completely while protecting their cellular structures, to survive periods without liquid water, either due to desiccation (anhydrobiosis) or freezing (cryobiosis). Whether or not cryptobiotic organisms are alive is not a straightforward question. Almost everyone agrees that they are not dead, since they can, often quite easily, resume normal functioning. However, during cryptobiosis their metabolism is entirely suspended, so they behave more like an inert object than like a living organism.

Some biologists do not consider cryptobiotic organisms to be alive. For instance, John Maynard Smith explicitly asserted that “[t]he maintenance of a living state requires a constant flow of energy through the system. A freeze-dried insect is not alive: it was alive, and may be alive again in the future” (1986: 2). James Clegg (2001) considers cryptobiotic organisms to be neither dead not alive, but in a different state altogether:

> “[c]ryptobiosis is peculiar in the sense that organisms capable of achieving it exhibit characteristics that differ dramatically from those of living ones, yet they are not dead either, so one may propose that cryptobiosis is a unique state of biological organization.” (Clegg 2001: 615)

He concludes that “there are three states of biological organization: alive; dead; and cryptobiotic” (Clegg 2001: 615).

Most philosophers seem to agree with this description. For example, Michael Wreen (1987) states that “it’s probably best to put suspended animation in a class by itself, distinct from both life and death”, although he does think that even though “it’s not clear that an organism is alive if it’s in a state of suspended animation”, it is “somewhat clearer that it’s not dead” (89). The reason that it is clearer that the organism is not dead than that it is not alive is that “metabolic capacity is much closer, conceptually speaking, to actual metabolizing – it is the capacity for such – than it is the absence of metabolic activity” (95). This leads him to say that “[c]reatures in a state of suspended animation are thus more nearly alive than dead”, although he insists that, strictly speaking, they are neither (95). Christopher Belshaw (2009) also considers organisms in suspended animation to be neither dead nor alive, because this is “a state in which function is lost, but reversibly so” (9). But it is at least debatable whether suspended animation involves loss of function, rather than just suspension of processes.

Feldman (1992) thinks that organisms cease to be alive when they undergo suspended animation, although they do not then die, as do Persson (1995) and Gilmore (2007, 2013). In contrast, Luper’s view is that a cryptobiotic organism remains alive, even while its vital processes are suspended:

> “Instead of saying that, in the case of seeds, spores, or frozen embryos, an organism’s life has been suspended or temporarily ended, let us instead say that its vital processes have been temporarily suspended, and that it remains alive while these stop. This is appropriate, because *an organism whose vital processes are suspended for a time still has, during that time, the capacity to maintain itself*, just as a sleeping person retains the capacity for consciousness.” (Luper 2009: 54, emphasis added)

Luper’s description of what happens in an organism in suspended animation is apt: its vital processes are temporarily suspended, but the organism retains the capacity to maintain itself, although it cannot exercise it at the moment. This accords well with the view of biologist David Wharton (2002), who argues that, although ‘cryptobiosis’ is the most commonly used term for this phenomenon, “[l]atent life is perhaps the most appropriate term, since, in the latent state, the capacity for life is present but is not apparent” (7).

The view that organisms in cryptobiosis are alive, although their metabolic activities are suspended, seems to be in the minority. Nevertheless, I will show that there are good reasons for considering cryptobiotic organisms to be alive.

6.4.1. Metabolism is necessary, but not necessarily continuous

To start with, cryptobiosis is the extreme end of a continuum of resistance adaptations to harsh environmental conditions that involves many different forms of dormancy, with different degrees of engagement in metabolism and other life processes. David Keilin, who introduced the term ‘cryptobiosis’, explains it in the following way:

> “In nature and under experimental conditions the same organism may show a complete gradation between the states of high biological and metabolic activity, a more or less deep dormancy, or torpor due to hibernation, aestivation, diapause or quiescence associated with a lower but still measurable metabolism (hypo-metabolism), and the state of ametabolic latent life, or cryptobiosis." (Keilin 1959:166)

Gilmore (2013) assumes that being metabolic at a given time is necessary for being alive at that time. In defence of this claim, he appeals to Margaret Boden, who argues that metabolism is necessary for life, *contra* the claims of strong A-life proponents. Boden (1999) characterises metabolism in a strong sense as “the use, and budgeting, of energy for bodily construction and maintenance, as well as for behaviour” (236). Metabolism involves “the autonomous use of matter and energy in building, growing, developing, and maintaining the bodily fabric of a living thing” (237). Nevertheless, while arguing that metabolism is necessary for life, Boden allows that interruptions in metabolism can happen:

> “Bodily maintenance is normally continuous. But the underlying metabolic processes are more active at some times — of the day, year, and life-cycle — than at others. Sometimes, they are drastically slowed down, or (perhaps) even temporarily suspended. (...) It’s not clear that this strong concept of metabolism assumes that active self-maintenance must be absolutely continuous, allowing of no interruptions whatsoever. If biochemical research were to show that metabolism is occasionally interrupted, in highly abnormal conditions (such as freezing), so be it. Indeed, we already speak of ‘suspended animation’: a spore may be currently inactive, but if it retains the potential to metabolise in suitable conditions we do not regard it as ‘dead’” (Boden 1999: 238).

Metabolism is necessary for life. But this does not mean that metabolism must be continuous at all times. Not all reactions happen all the time. Plants, for example, only photosynthesise during the day (although respiration continues at night); deciduous trees can spend the whole winter without photosynthesising. Genes are translated as needed; not continuously. If metabolism consists of a large number of biochemical reactions, each of which is not necessarily occurring at any particular instant, then the requirement of continuous metabolism amounts to the demand that *some biochemical reaction or other* must always be proceeding at each and every moment during the whole life of an organism, which seems unprincipled.

Furthermore, it is not only in cryptobiotic organisms that gaps or interruptions in metabolism can occur. Metabolic depression can be caused by any number of environmental stressors, and can affect different aspects of metabolism. For example, marine *Vibrio* sp. bacteria decrease their protein synthesis to less than 1% after 3 days of starvation, as part of a range of metabolic adjustments called “stringent control response” (Hand & Hardewig 1996: 547). Metazoan cells subject to hypoxia downregulate metabolism, especially protein translation, to prevent a “bioenergetic collapse” (Wheaton & Chandel 2011). Cysts of the brine shrimp *Artemia* cease metabolism entirely in the absence of oxygen, which is a form of cryptobiosis (anoxybiosis), even while fully hydrated and at room temperature (Clegg 2001).

Organisms that undergo dormancy, deep hibernation, and other periods of decreased activity reduce their metabolism to a fraction of the normal active state, while falling short of stopping metabolism altogether. It is nonetheless possible, especially during periods of reduced metabolic rate, that there may be short gaps in metabolism, i.e., that brief pauses might occur in all chemical reactions simultaneously, purely by chance. Such a gap might be improbable, but it is not impossible. If we detected a gap in a cell’s metabolic activity, we would not say that it had died and come back to life, or that it was neither dead nor alive for a brief moment; we would say that the cell was alive throughout, even if its metabolism stopped for a microsecond. Of course, in cryptobiosis, metabolism stops for much longer: some organisms can remain in a cryptobiotic state for months or even years. But the situation is not metaphysically any different from that of an organism whose metabolism was only briefly interrupted. As long as its structural integrity is maintained and the organism is viable, the difference is only a matter of degree.

6.4.2. Cryptobiosis is part of the life of the organism

Are gaps in metabolism, either short or prolonged, necessarily gaps in the life processes of the organism? This depends on what we understand by life processes – if we equate life processes with metabolism, then these do indeed come to a halt during cryptobiosis. Nevertheless, processes extend over time, and may involve many distinct components. The life of an organism might be seen as more akin to a complete musical piece or dance performance, than to a single movement. Just as it is reasonable to consider the pauses in the music or dance performance to be part of the music or dance, it can also make sense to consider the pauses in metabolism as part of the life of an organism. In fact, cryptobiotic periods are well integrated into the life of organisms with this capacity.

The capacity for cryptobiosis is an evolved biological adaptation that contributes to the fitness of the organism, allowing it to survive in environmental conditions that would ordinarily result in death. Cryptobiosis is integrated into the life histories of organisms that have this capacity; it determines what habitats are suitable for colonisation, conditions the reproductive strategies of the organisms, and even alters their rate of evolution. For instance, tardigrades, which are minute aquatic animals, are found in larger numbers and highest species diversity, not in freshwater, but in habitats which are often subject to desiccation or freezing (Guidetti et al. 2011). Cryptobiosis allows these animals to colonise terrestrial environments, including unpredictable and extreme habitats (Nelson et al. 2018).

Organisms actively prepare their cryptobiotic phases, just like they prepare for lighter dormancy forms such as hibernation (for example by accumulating fat reserves). They may also choose an appropriate place. Wood frogs, for example, burrow under some leaf litter before freezing. Tardigrades form a tun, contracting their cuticle and retracting their limbs, prior to desiccation. This significantly reduces their permeability, allowing the animal to slow down the rate of desiccation while it makes metabolic preparations for anhydrobiosis (Wright 2001). Cryptobiotic animals synthesise bioprotectant substances, such as trehalose, glucose, and molecular chaperones, in order to stabilise membranes and other cellular structures, and prevent protein denaturation, thus avoiding most of the intracellular damage caused by dehydration and/or freezing.

Cryobiotic organisms also actively prepare for freezing. Freeze-avoidant organisms such as some insects, which can survive at very low temperatures in a supercooled state, avoid direct contact with ice, to prevent sudden freezing by ice inoculation. Freeze-tolerant organisms, in contrast, actively seek contact with ice, to ensure that the freezing process takes place at a relatively high subzero temperature. The process of freezing takes about 24 hours in the wood frog. At the start of the freezing process, glucose concentration in the frog's blood increases 100 to 200 times, and the heart beats very fast due to the release of adrenaline (Wharton 2002). The increased heart rate ensures that the glucose is quickly distributed to all the tissues, where it acts as a cryoprotectant. The heart rate eventually slows down and the liver and heart are the last organs to freeze. During thawing, the heart is the first organ to recover, and starts to beat even before thawing is complete. Normal behaviour is established within 24 hours (Wharton 2002: 182-184).

Interestingly, in their natural habitat in Alaska, wood frogs typically undergo several freeze-thaw cycles before remaining frozen for the winter, and these repeated freeze-thaw cycles stimulate the frog to produce higher amounts of cryoprotectant glucose (Larson & Barnes 2016). Many other organisms undergo repeated cryptobiotic periods, and some spend far more time in cryptobiosis than they do actively metabolising. Some arctic insects can only grow during a short period during the summer. The moth *Gynaephora groenlandica*, for instance, can take up to 14 years to complete its life cycle, surviving during the winter in a cryobiotic state and resuming development for brief periods in the summer (Wharton 2002: 67).

In the case of artificially induced cryptobiosis in organisms that do not normally undergo it, such as the freezing of cells in laboratory settings, it might seem harder to argue that this kind of suspended animation is a natural biological function that is well integrated into the life of the organism. Nevertheless, there is nothing peculiar in claiming that, just as doctors perform artificial fertilisation by injecting a sperm cell into an oocyte, scientists also induce artificial cryptobiosis when preserving cells or organisms in cryogenic conditions. Though artificially produced, the cryptobiotic period becomes part of the life of the organism thus suspended.

6.4.3. Cryptobiotic organisms can die

Cryptobiotic organisms suffer mortality over time. The proportion of organisms that recover from anhydrobiosis declines with time (Wharton 2002: 105). These deaths might be due to oxidation damage which the organisms are unable to repair while ametabolic. Cryptobiotic organisms may also be in more or less healthy condition, or even ‘dying’. For instance, a cryptobiotic organism that suffers lethal damage which does not prevent its viability can recover from cryptobiosis only to die shortly after:

> “Howard Hinton, formerly Professor of Entomology at the University of Bristol, working on anhydrobiotic larvae of the midge *P. vanderplanki*, reported that a larva which had suffered damage to its body wall while dry had a portion of its gut forced through the wound when it was immersed in water; it recovered activity only to die some four hours later.” (Wharton 2002: 105)

Cryptobiotic organisms have a limited life expectancy, which varies according to the species and the environmental conditions experienced during cryptobiosis. The time limit on the survival of anhydrobiotic organisms has to do with the accumulation of chemical damage which cannot be repaired. For example, anhydrobiotic organisms have better survival when stored in an atmosphere without oxygen, since oxidation damage is a major cause of death for these organisms. Storage in the dark and at low temperature also increases survival (Wharton 2002: 105).

As mentioned in §6.3, philosophical discussions of suspended animation have focused excessively on technology. This has led many towards the view that whether something is alive depends on what technology is available. A case in point is Snowdon’s remark that if “there is no viable resuscitation process then freezing the animal does in fact kill it” (2014: 114). But it is far from clear that freezing an animal always kills it. The freezing process itself *might* kill the animal; in the absence of adequate cryoprotection, ice crystals would damage the cellular structures, causing death before the animal has a chance to enter cryptobiosis. But if it does not, the animal enters cryptobiosis and is then still alive. If it cannot recover on its own, and no technological intervention permits its recovery, it will remain alive in an ametabolic state until oxidation damage destroys its cellular structures. In this case, freezing the animal does not kill it, but the damage it suffers while frozen does.

6.5. Life, suspended

Organisms in suspended animation are neither dead, nor in an intermediate state between dead and alive; they are alive. The existence of living organisms in a completely ametabolic state, however, seems hard to square with the thesis that organisms persist over time in a different way from other material objects due to their capacity to exchange matter and energy with the environment.

The organism in suspended animation is still able to resume its life processes. It is like an active volcano that is not erupting at the moment, or an unconscious person who cannot, at the moment, reason or deliberate (Rosenberg 1983: 57-58) Likewise, an ametabolic organism is still an organism, although at the moment it cannot grow, repair its own tissues, synthesise proteins, etc. However, it does not seem to persist over time in a different way from other material objects, which might constitute an objection to the account of organismal persistence proposed in this thesis.

One possibility is to claim, as van Inwagen (1990) does, that life, which ordinarily consists in "large-scale physical processes (the breaking and establishing of chemical bonds, the movement of fluids under hydraulic pressure, the transport of ions)" might, in cryptobiotic organisms, be "'squeezed into' various small-scale physical processes (the orbiting of electrons and the exchange of photons by charged particles)" (147). He considers the hypothetical case of a frozen cat. Although referring to it as a 'living corpse', van Inwagen thinks the cat's life continues in a state of suspended animation:

> "The atoms of which the feline corpse [sic] is composed continue to be bonded to one another (…) All the fragile molecules of life persist, properly arranged and bonded, inside the cat (…). Because all these chemical bonds persist unchanged in the frozen cat, and because these bonds were established by the operations of the cat's life, I find it attractive to suppose that the cat's life persists even when the cat is frozen." (van Inwagen 1990: 146)

While I do not find it plausible to say that life can be 'squeezed into' subatomic physical processes, van Inwagen's observation that the molecules of life "persist, properly arranged and bonded" makes sense on the living objects view. The fact that most of the composite objects that are part of the cat (such as molecules, cells, etc), their bound states, and relative spatial positions and topological relations, continue in the frozen state, means that the cat continues to be a physical object that (in virtue of enough physical structure being preserved) continues to have the capacity to engage in and coordinate metabolic processes, even though it is not exercising this capacity at the moment. As noted in §3.2.1, the importance of physical structure for organisms is one of the motivations for the living objects view. The existence of living but ametabolic organisms demonstrates that physical structure is even more important for the persistence of organisms than active metabolism.

Biologists studying cryptobiosis agree on the importance of physical structure. Keilin states that

> “The concept of life as applied to an organism in the state of anabiosis (cryptobiosis) becomes synonymous with that of the structure, which supports all the components of its catalytic systems. Only when the structure is damaged or destroyed does the organism pass from the state of anabiosis or latent life to that of death.” (Keilin 1959: 187)

Clegg also concludes that “it is the structural organization of cells and organisms, rather than their dynamics, that represents the most fundamental feature of living systems.” (2001: 615)”. This is because an organism’s capacity to engage in and coordinate metabolic activities is due to its physical structure.

The importance of intact structure is also emphasised by ‘anti-terminators’ such as Mackie, who defend the existence of dead organisms. But what is required for the continued existence of living organisms through cryptobiosis is precisely the “implausibly strong requirement” that “it is necessary for the persistence of [an organism] that it actually *be apt* for life, if that is understood as meaning that it would have to be so perfectly intact that it might in principle be revivable” (Mackie 1999: 241, n. 22). Unlike Mackie’s vague requirement that organisms exist while the organisation of their constituent parts ‘remains sufficiently intact’, the requirement that the organism continues to exist while its intact structure maintains its capacity for life is crystal clear. Compare Keilin on cryptobiotic organisms: “[t]he stability of such an organism is of a purely static nature (…); and as long as the structure of these organisms remains intact they retain the ability to return to normal active life” (Keilin 1959: 187). What is essential for the persistence of an organism is that enough of its physical structure is maintained, such that the organism is able to resume metabolic activity. It is only when this structure is irreversibly damaged that death occurs.

Recently, Skowronski (2023) argued for a dispositional modification of van Inwagen’s (1990) criterion of composition:

> “The *x*s compose *y* iff the *x*s are disposed to engage in activity that constitutes a life.” (Skowronski 2023: 27)

As an ‘organicist’ criterion of composition, Skowronski’s view inherits the problems facing van Inwagen’s view. But being “disposed to engage in activity that constitutes a life” is a suitable description of the persistence of organisms in cryptobiosis. As Hershenov (2005) points out, if someone wants to claim that an organism in suspended animation continues to exist “as long as the disposition to carry out life processes remains intact”, they must admit that *structure* is essential (2005: 50, n. 24).

6.6. Conclusion

Organisms are essentially living objects, and they cease to exist when they die. Death consists in the complete and irreversible cessation of the capacity to engage in and coordinate metabolic activities. Composite organisms such as multicellular organisms have their own lives over and above the lives of their component organisms; therefore, they also die separate deaths. It is possible for some organisms to survive in a natural or artificially induced state of cryptobiosis in which all metabolic activity stops. I have argued that cryptobiotic organisms are alive, despite being ametabolic. The fact that they persist in a similar way to inert material objects might be thought to constitute an objection to the metaphysical view of organisms developed in this work. However, cryptobiotic organisms retain the capacity to engage in and coordinate metabolic activities and other life processes. The fact that organisms survive in cryptobiosis in virtue of the preservation of the physical structure that confers them the capacity to engage in life processes shows the adequacy of considering organisms as living physical objects.

Conclusion

This thesis is a metaphysical inquiry into what we are and how we persist. Although these questions have traditionally fallen under the scope of the 'metaphysics of personal identity', I have taken a broader approach, which is not primarily concerned with persons as such, but attempts to integrate our metaphysical nature within a wider ontology of the natural world.

From a naturalistic perspective, a good starting point in this investigation is what science has to say about our nature. The scientific consensus is that we are animals; therefore, animalism should be the default view of personal identity. Furthermore, animalism is well supported by several arguments, and the main objections to it can be rebutted. However, animalists have not been very precise in formulating the view, claiming that we are *animals*, *human animals*, or *organisms*, often interchangeably. I have argued that the first two terms refer to phylogenetic groups, which are either not natural kinds at all, or are natural kinds defined exclusively by extrinsic properties. As such, they do not identify our fundamental nature, but only provide information about our location on the phylogenetic tree. Although we are certainly animals, and more specifically human animals, we could have existed and not belonged to these taxa, and we do not have our persistence conditions in virtue of our membership in them. In contrast, 'organism' faces none of these problems. I conclude that we should maintain strong animalism, formulated as the claim that we are essentially organisms.

I have presented a novel account of organisms as living material objects. I argue that we should accept a metabolic view of life, which states that to be alive is to have the capacity to engage in and coordinate metabolic activities. Metabolism involves the selective exchange of matter and energy with the environment, and therefore requires physical structure, especially a semi-permeable boundary that contains the organism within a restricted spatial location and allows for selective exchange of materials. For this reason, organisms are necessarily physical objects. The *living objects* view combines a naturalistic answer to the special composition question, the *bound state view*, which states that objects are bound states of matter, with a metabolic criterion of life. This view overcomes the problems with extant accounts of organismality, which often make problematic metaphysical assumptions about composition, and places organisms within a general scientific ontology that avoids the problems facing eliminativist accounts of composition.

Inherent in their nature as living objects is the capacity of organisms to produce, maintain, repair, destroy, and reconstruct their own bound states through metabolic activities. This means that organisms persist over time in a distinct way from other material objects, insofar as their bound states are partly produced and maintained by the actions of the organisms themselves. For this reason *organism* should be considered a persistence kind. The living objects view suggests that an organism persists while it continues to be a physical object and continues to be alive. However, this does not suffice as an account of persistence because, like other continuity-based accounts, it faces the problem that in cases of fission and fusion, more than one object can fulfil these criteria. Therefore, I propose the *essential physical structures account of organismal persistence*, which includes the additional condition that there should be no sudden loss, acquisition, or replacement, of more than 50% of the physical structures that allow the organism to engage in and coordinate metabolic activities, where physical structure includes bound states and spatial relations between components.

The bound state view allows for composite objects to form other composite objects in turn, which is an advantage of this view, as it can account for many composite objects that are part of organisms, which cannot be accounted for on eliminativist views. Since organisms are also composite objects, the view allows for organisms made of other organisms – *composite organisms*. Multicellular organisms, such as ourselves, are an example of a composite organism that is partly composed of other living organisms, the cells. The fact that an object is composed of other living objects does not automatically make it an organism, though, unless it has its own life, i.e. unless it has the capacity to engage in and coordinate metabolic activities itself, over and above the metabolic activities of its component organisms. While cells come into being through fission or fusion of previously existing living cells, multicellular organisms usually come into being through development, and I have looked at the difficult question of when the life of a multicellular organism begins.

I have argued that the life of a multicellular organism cannot start at fertilisation, since the zygote ceases to exist when it divides, and the early embryo is not an organism, since it is not itself alive, even though it is an object composed of living cells. The life of the multicellular organism begins when it acquires the capacity to coordinate its life processes at the multicellular level of biological organisation, but it is hard to specify exactly when this happens during development. I have assessed several hypotheses, and concluded that the beginning of multicellular life for organisms such as ourselves can be constrained as no earlier than the inception of global coordination of metabolic activity and no later than the development of a functional central nervous system.

Organisms can cease to exist without dying, in some cases of fission or fusion, whereby their life processes continue in numerically different organisms, or through death, which consists in the complete and irreversible loss of the capacity to engage in and coordinate metabolic activities. If organisms are essentially living objects, it follows that they cease to exist when they die. Thus, a corpse is a numerically different object that comes into existence when an organism dies. I dispute several objections to the termination thesis, and argue that they can be overcome without adopting corpse eliminativism. Furthermore, I argue that it is impossible for something to die and later live again, and that cryptobiotic organisms are alive, even though they are ametabolic. Organisms can survive in this state of suspended animation while they retain enough of their physical structure that allows them to resume metabolic activities under suitable conditions. This shows the importance of physical structure for life, and the adequacy of the living objects view.

This thesis develops a naturalistic metaphysical view of living beings. Four aspects that deserve future work are as follows:

(1) The development of a universal theory of life, as Cleland argues, is what is needed rather than a definition of life. In my view, however, we have more reason to be hopeful that this might be possible even in the absence of the discovery of extraterrestrial life. By focusing on biophysical and biochemical constraints on the ways that life can be, it may be possible to identify universal features of life. This is an extremely worthwhile project which requires both scientific and metaphysical perspectives.

(2) What are the implications of the living objects view for a wider range of problems in the philosophy and metaphysics of biology? Although I have examined some important problem cases, others also deserve further study – for example, conjoined twins, organoids, various kinds of symbiotic partnerships, etc.

(3) A closer look at development would be needed in order to determine, more accurately, when multicellular organisms (and human beings in particular) begin to globally coordinate metabolic activities. Research into early embryonic development, as well as genetic, epigenetic and biophysical determination of the fate of cells is an active area of research where important scientific advances are to be expected in coming years, which might have consequences for our understanding of the metaphysics of composite, in particular multicellular, organisms.

(4) The elucidation of the coordinating and regulatory functions of the brainstem and other brain structures, as well as the coordination capacity of extra-neural parts of the organism and, relatedly, an assessment of the role of sentience in coordination of the life of organisms with central nervous systems.

Some important implications of the findings presented here can be drawn: if we are organisms, and our persistence conditions are those of organisms, understood as living material objects, it follows that we could not possibly survive teletransportation, mental ‘uploading’, and the like. It is also highly unlikely that human beings could survive fission, since the brainstem seems to be an indispensable structure such that its division would be incompatible with life. In contrast, it is reasonable to assume that we can, and many of us do, survive conditions like unresponsive wakefulness syndrome. This is important from both ethical and prudential perspectives.

This thesis does not draw any ethical implications from ontological considerations. I think that no ethical implications straightforwardly follow from anything argued here; however, ethical views should be informed by an adequate ontological picture.

Appendix 1. Phylogenetic systematics

This appendix contains additional information on phylogenetic systematics. It appears with slight changes in the following publication: Hermida (2022). Cats are not necessarily animals. *Erkenntnis*, forthcoming. https://doi.org/10.1007/s10670-022-00588-w

Although historically there have been multiple classification systems in biology, ever since Darwin, – to be fair, even before, though not explicitly – the main classification system in biology is genealogical. Today, this means phylogenetic systematics, also known as cladistics. In the twentieth century, three distinct classification systems were proposed – cladistics, phenetics, and evolutionary taxonomy.

Evolutionary taxonomy aimed to be mainly a genealogical classification, but which also incorporated evolutionary change or divergence. According to this classification system, higher taxa should only include descendant species of a certain ancestral species, but they need not include *all* of those descendants; i.e., *paraphyly* was accepted. For instance, birds and mammals were given a rank comparable to that of reptiles because they were considered to have diverged quite considerably from them. So although classification had an evolutionary basis, there was plenty of subjectivity involved in deciding which groups were sufficiently different from which other groups (Richards 2016: 107-12). In evolutionary taxonomy, the ranking of higher taxa was supposed to reflect the degree of divergence, diversification, and also evolutionary age of the different groups; however, when these conflicted, rankings would be a matter of judgement on the part of the taxonomist. Questions such as how many species should be included in a genus, for instance, were also to some degree a matter of preference, and genera containing very many species could be split for convenience.

Phenetics (or ‘numerical systematics’) rejected the evolutionary basis of taxonomy, mainly on the grounds that evolutionary relationships were poorly known, and attempted to eliminate subjectivity by classifying organisms purely by degree of similarity. Characters were identified and measured, and then statistical methods would be applied to yield a phenetic classification, ranked by degree of similarity. Unfortunately, this approach turned out to introduce high levels of subjectivity back into the classification: first, in deciding what counts as a character; then, in deciding how to code the characters; then, in choosing a coefficient of similarity, with each one generating a different classification, and so on. But another important problem was that, in rejecting phylogeny, this classification was simply irrelevant to most of biology.

In contrast, phylogenetic systematics, which is used today, is a purely genealogical classification. It aims to be as objective as possible, by eschewing all judgements of similarity. It simply aims to represent the actual phylogenetic history of organisms. The groups that compose it do not depend on scientists' subjective opinions of which organisms look more similar, or what constitutes an important evolutionary innovation. Instead, phylogenetics works exactly like a family 'tree' that represents, as accurately as possible given what is known, someone's ancestors and the genealogical relationships between them. So, for instance, while in evolutionary taxonomy, sarcopterygians (fleshy-finned fishes that gave rise to the tetrapods) were classified together with actinopterygians (ray-finned fishes), because of their fish-like features; in modern phylogenetic classification, they are classified together with all of the terrestrial vertebrates, to which they are more closely related. If this sounds surprising, we should bear in mind that the purpose of phylogenetic classification is not to group together organisms which are more similar, but to capture their genealogical history.

In phylogenetic systematics, only monophyletic clades are accepted. A monophyletic clade (Fig. 3) is a group that includes a stem species plus all, and only, its descendants (Hennig 1966; Wiley and Lieberman 2011). The stem species thus defines the clade, which is composed of that particular species and all its descendants. New clades are generated (a process known as cladogenesis) whenever there is a speciation event, i.e. whenever a species divides into distinct species. When this happens, the original species which existed prior to the speciation event becomes the stem species of the new clade; it is the ancestor species of all the species within that clade. Later, when some of its descendant species themselves speciate, more clades are formed. Importantly, though, all of these clades are still sub-clades of the original clade. If a species belongs to a certain clade, neither it nor any of its descendants can ever 'move out' of it (Okasha 2003). This is so regardless of whatever traits they might lose, or acquire.

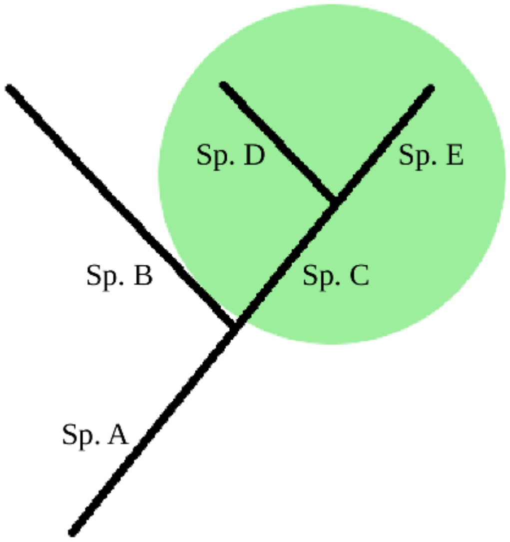

Figure 3. Example of a phylogenetic tree. The clade composed of species C, D and E is monophyletic, since it includes species C (the stem species of this clade) and all of its descendants.

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