



# Towards a characterization of metaphysics of biology: metaphysics *for* and metaphysics *in* biology

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## Abstract

Since the last decades of the twentieth and the beginning of the twenty-first century, the use of metaphysics by philosophers when approaching conceptual problems in biology has increased. Some philosophers call this tendency in philosophy of biology ‘Metaphysics of Biology’ (Guay and Pradeu in *Synthese* 1–20, 2017). In this paper, I aim at characterizing Metaphysics of Biology by paying attention to the diverse ways philosophers use metaphysics when addressing conceptual problems in biology. I will claim that there are two different modes of doing Metaphysics of Biology, namely Metaphysics *for* Biology and Metaphysics *in* Biology.

**Keywords** Philosophy of biology · Metaphysics of biology · Metaphysics *for* biology · Metaphysics *in* biology

Philosophers have long been interested in biology, as the writings of Aristotle, Descartes, Leibniz, and Kant show. Yet, according to what can be called ‘the standard view’<sup>1</sup> among philosophers of biology, philosophy of biology emerged as a discipline in the 1970s, coinciding with the fall of logical empiricism and the acknowledgment of the particularity of other scientific disciplines besides physics, such as psychology and biology (Callebaut, 1993, 2005; Hull, 1969, 2002; Rosenberg, 1985; Ruse, 2000). Philosophers started to pay more attention to the biological sciences and to be aware of the internal conceptual problems that characterize the theories developed in these fields (Callebaut, 1993, p. 74).

<sup>1</sup> Currently, recent work points to the development of the organicist school during the first half of the twentieth century as an illustration that there was philosophy of biology before the 1970s (Nicholson and Gawne 2015, pp. 347–348). Yet, despite this precursor, it is widely accepted by philosophers that philosophy of biology as such started in the 1970s (Hull 1969).

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According to the standard view, before the 1970s philosophers did not properly pay attention to what was going on in biology, and the communication between philosophers and biologists was almost nonexistent (Hull, 1969). In this regard, Ralph S. Lillie's review on James Johnstone's *Philosophy of Biology* (1914) is a good illustration of the philosophers' lack of interest and knowledge of the biological sciences:

We have noted some errors in matters of biological detail [...]. The brief account of certain physiological processes seems somewhat out of date; the account of the nerve impulse is unsatisfactory, and certainly few physiologists now hold that a muscle is a thermodynamic machine in the sense conceived by Engelmann; there is some evidence of unfamiliarity with biochemistry: the term "animo-acid" instead of amino-acid recur a number of times [...] (Lillie, 1914, p. 846).

The advocates of the standard view consider that the lack of communication between philosophers and biologists was, at least in part, a consequence of the philosophers' use of formalistic language. Due to the prevalence of logical positivism, the formalization of biological theories was the main way philosophers used to approach conceptual problems in biology. This formalistic language, besides being unintelligible to biologists, also deviated the attention from the biological problem at stake. Philosophers were more worried about whether a particular formalization was correct and whether there could be alternatives to it (Hull, 1969).

In this sense, it was the fall of logical positivism, during the 1960s and 1970s, what gave rise to a new approach to biology, one in which biology itself was seriously considered and studied by philosophers. It is this new way of paying attention to biology by philosophers that is considered to be properly called 'Philosophy of Biology', or the 'New Philosophy of Biology' (Callebaut, 2005, p. 99). Philosophers started to pay more attention to the biological sciences (particularly, to evolutionary biology), and, as a result, biologists started to consider the philosophers' work more seriously (Hull, 2002; Callebaut, 2005, p. 107).

Werner Callebaut characterizes philosophy of biology as the discipline in which philosophy contributes to improving our understanding of the relevant conceptual biological issues at stake (Callebaut, 2005, p. 101). Initially, these conceptual issues were mainly those generated within the theoretical framework of the Modern Synthesis of Evolution, such as those concerning fitness, natural selection, genes, or mutation, among others. However, since the late 1990s, and due to the new empirical and theoretical developments experienced by evolutionary biology, philosophers of biology started to pay attention to other conceptual issues beyond those that had worried the architects of the Modern Synthesis, such as those concerning evolvability (Sterelny, 2010), phenotypic plasticity (Pigliucci, 2001), or epigenetic inheritance (Jablonka & Lamb, 2005). Philosophy of biology, notwithstanding, continued having a positivistic flavor. This is illustrated by the efforts made to axiomatize and formalize biological theories, such as the evolutionary theory, and the predominance of an epistemological and methodological approach when addressing different biological concepts and questions (Schaffner 1969; Sober, 1984; Waters, 1994; Godfrey-Smith, 2000, 2008; Shea, 2013; Millstein, 2002, 2005; Brandon, 2005; Lewens, 2007; Lean, 2014).

During the end of the twentieth and the beginning of the twenty-first century, there has been a renewed interest in metaphysics after its banishment by the logical

positivists.<sup>2</sup> Philosophers have tended to widely acknowledge the usefulness of metaphysics when dealing with conceptual and theoretical problems in different biological disciplines such as evolutionary biology, evolutionary and developmental biology (evo-devo), developmental biology, and molecular biology (see Boogerd et al., 2005; Dupré, 2012, 2015; Austin, 2016a, 2016b; Waters, 2017; Nicholson & Dupré, 2018). Some authors have used the term ‘*Metaphysics of Biology*’ to name this increasing tendency in philosophy of biology (Guay & Pradeu, 2017).

The increasing appeal to metaphysics by philosophers of biology is a phenomenon that deserves more attention in order to clarify how they use metaphysics when approaching conceptual problems in biology, i.e., how *Metaphysics of Biology* is done. In this paper, I aim at clarifying this use of metaphysics by paying attention to the extant literature in philosophy of biology in which conceptual problems in biology have been addressed from a metaphysical perspective. In doing so, I will propose a categorization of two different ways metaphysics of biology takes place: *Metaphysics for Biology* and *Metaphysics in Biology*.

The structure of the paper is as follows: Firstly (Sect. 1), I propose a categorization of two different ways of doing *Metaphysics of Biology*, what I have called *Metaphysics for* and *Metaphysics in Biology*. In doing so, I make precise that whether a problem is part of one category or another will be a question of emphasis. Furthermore, I also highlight the possibility for cases of crossfertilization to take place. In (Sect. 2), I introduce *Metaphysics for Biology* in more detail, illustrating this form of doing *Metaphysics of Biology* with two examples in the literature, namely the classic debate regarding the characterization of fitness (Sect. 2.1), and the contemporary debate about the characterization of the ontological status of holobionts (Sect. 2.2). In (Sect. 3), I characterize *Metaphysics in Biology* by dwelling on different examples in which an exploration of the ontological assumptions and implications given in the biological theories (Sect. 3.1), the biological phenomena (Sect. 3.2), and the biological practices (Sect. 3.3) take place. Finally (Sect. 4), I close with some concluding remarks.

## 1 Metaphysics of biology

The increasing appeal to metaphysics within philosophy of biology since the last decades of the 20th and the beginning of the twenty-first century is a phenomenon that deserves more attention in order to clarify how philosophers use metaphysics,

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<sup>2</sup> Someone can point out that some of the most classical debates in philosophy, such as the debate regarding the characterization of biological species, has been mainly addressed from a metaphysical perspective, exploring whether species are real entities existing in nature or just human constructions (Dobzhansky, 1935; Ereshefsky, 1998). And, assuming they are real entities, whether they are classes (Hull, 1965) or individuals (Ghiselin, 1974, 1997; Hull, 1976, 1978, 1980). In this regard, it is important to make precise that, although the classic problem regarding the characterization of biological species is an example of a metaphysical problem, the main tendency when approaching conceptual biological problems since the appearance of philosophy of biology as a discipline was not metaphysical. Philosophers of biology, such as David Hull, Philip Kitcher, Alexander Rosenberg or Elliot Sober, were mainly formed in analytic philosophy and within the logical-empiricist tradition. And they mainly use epistemological and methodological resources when addressing conceptual problems in biology (Callebaut, 2005, p. 107; See also Mayr, 2004).

and therefore, how Metaphysics of Biology is done. In this section, after paying attention to the extant literature in philosophy of biology in which conceptual problems in biology have been addressed from a metaphysical perspective, I propose a categorization of two different forms philosophers use metaphysics, and thus, of two different ways Metaphysics of Biology can take place, namely *Metaphysics for Biology* and *Metaphysics in Biology*.

In *Metaphysics for Biology*, philosophers appeal to metaphysics in order to clarify a biological concept. In particular, they recur to the different metaphysical theories and concepts they might consider more accurate to explore and determine the ontological status of the entity to which the biological concept refers. In doing so, the biological concept itself is clarified. In *Metaphysics in Biology*, on the other hand, philosophers explore and make precise the metaphysical commitments and implications that can be found in the different biological disciplines. In this case, therefore, philosophers of biology pay attention to biological theories, phenomena, and practices in order to disentangle the metaphysical commitments and assumptions that are given in them. In doing so, philosophers of biology are able to clarify and shed light on the biological theories, phenomena, and practices themselves.

As we will see (Sects. 2 and 3), different examples in the literature can serve as an illustration of each mode of doing Metaphysics of Biology. Yet, it is important to highlight that the question regarding the particular mode that is taking place in each case is a question of emphasis. Thus, in *Metaphysics for Biology*, the emphasis is placed on the metaphysical theories and concepts that are used, and the way they might serve to clarify a biological conceptual problem. In *Metaphysics in Biology*, conversely, the focus is placed on biological theories, practices, and phenomena, in order to explore the ontological implications and commitments they have.

Depending on where the philosopher is placing the emphasis one debate or problem can be characterized as being part of *Metaphysics for* or *Metaphysics in* Biology. In this regard, there are no *Metaphysics for* Biology problems, on the one hand, and *Metaphysics in* Biology problems, on the other. Since we are talking about different modes of performing Metaphysics of Biology, the specific place wherein a problem might be situated will depend on the philosopher's emphasis. This idea will be illustrated in the following sections with the contemporary debate in biology and philosophy of biology regarding holobionts. As we will see, the debate on holobionts can be characterized as an example of both *Metaphysics for* and *Metaphysics in* Biology. It will be an example of *Metaphysics for* Biology in those cases in which the focus is placed on the metaphysical theories and concepts that are used to characterize their ontological status (see Sect. 2.2). Furthermore, it will also be an example of *Metaphysics in* Biology in those cases in which the focus is on the exploration of the metaphysical commitments and implications that are given in a particular biological theory about them (see Sect. 3.1). Regarding this point, it is also important to highlight that, although there can be clear cases in which the question about the emphasis can be easily solved, there could also be other cases in which the answer is not so clear. These cases might be given when the philosopher is using both modes of doing Metaphysics of Biology simultaneously, for instance.

Besides the question of the emphasis, when doing Metaphysics of Biology cases of *crossfertilization* can also take place. This occurs when the results obtained by

philosophers of biology in metaphysically addressing conceptual problems in biology affect the metaphysical theories or concepts initially used by improving, modifying, or extending them. Crossfertilization does not always need to occur. Yet, in the following sections, I will illustrate this feature of the Metaphysics of Biology with one example given in *Metaphysics for Biology*, namely, the case of fitness (see Sect. 2.1); and with another example given in *Metaphysics in Biology*, i.e., the case of biological species (see Sect. 3.3).

## 2 Metaphysics for biology

As previously stated, *Metaphysics for Biology* is one of the forms in which philosophers can use metaphysics when addressing a conceptual biological problem. In this case, philosophers recur to the metaphysical framework they consider to be more accurate in order to determine the ontological status of the entity to which the biological concept refers. In doing so, the biological concept itself is clarified. Different examples in the literature might serve to illustrate this kind of interaction. Some of them include the use of the so-called dispositional theory of causation to clarify the biological concept of gene (Mumford & Anjum, 2011) or the classical concept of fitness (Triviño & Nuño de la Rosa, 2016); the appeal to the metaphysical notion of ‘emergence’ to characterize developmental modules in evo-devo (Austin, 2016b; Boogerd et al., 2005; Brigandt, 2015; Walsh, 2013), and the holobionts individuality (Suárez & Triviño, 2019, 2020); or the appeal to ‘natural kinds’ to shed light on the conceptualization of homologies and body plans (Griffiths, 1999; Hall, 1996; Rieppel, 2005; Wagner, 1996). In all these examples, metaphysical concepts and theories (dispositional causation, emergence, and natural kinds) are the reference framework for clarifying the nature of biological notions.

In order to better show what this interaction consists of; I will dwell on two cases in more detail: the metaphysical approaches to the concepts of fitness and holobionts. Given that the nature of fitness is one of the most classical puzzles in evolutionary biology and its philosophy, and that the debate regarding the concept of holobiont is a very recent one, these examples shall be representative enough.

### 2.1 The case of fitness

Fitness is a key concept in classic evolutionary biology. However, despite its importance, there are problems regarding its definition. Usually, fitness has been identified with the actual number of offspring left by an individual or type. In this sense, the fitter an organism is, the more offspring it has. This ‘actualist’ account of fitness, notwithstanding, has been widely challenged and criticized. Among other problems, it has been considered that the definition is a tautology, and therefore, that it lacks explanatory power: If we seek to explain why an organism *A* leaves more offspring than an organism *B*, the explanation “because *A* is fitter than *B*” is circular if “*A* is fitter than *B*” means “*A* leaves more offspring than *B*” (Brandon, 1978; Rosenberg, 1985). In other words, if the fittest organisms are the reproductively successful ones,

then those reproductively successful organisms are reproductively successful (Brandon, 1978; Burian, 1983; Millstein, 2016; Rosenberg, 1985). Furthermore, it has also been argued that the actualist account is unable to capture the distinction between evolution by natural selection and evolution by genetic drift, what is called ‘the mismatch problem’: Accidents might occur in nature such that an organism might out-reproduce another one without being the fittest. Yet, since fitness refers to the actual reproductive outcome of organisms, biologists would not be able to distinguish between this case of chance and a case of natural selection, that is, a case in which differences in the actual number of offspring are caused by some phenotypic difference in organisms (Beatty, 1984; Brandon, 1978, 1990, 2005; Millstein, 2002, 2005).

In the actualist account, fitness is just a mathematical parameter. The actual number of offspring an organism has is a form of measuring how fit an organism is, but it is not a way of explaining what fitness is. In the same way, the degrees marked by a thermometer are a form of measuring the temperature, but not a characterization of what temperature is. In order to avoid the problems of the actualist account, philosophers of biology tried to offer a characterization of fitness by specifying its ontological status. Alexander Rosenberg, for instance, offered a *supervenient approach* in which fitness is a supervenient property of organisms. In this account, the actual number of offspring is only a way of measuring the level of fitness an organism has (Rosenberg, 1978). Roughly at the same time, Robert Brandon (1978), as well as Mills and Beatty (1979), offered a *propensity interpretation of fitness*, according to which fitness is the ability of organisms to survive and reproduce in a particular environment and population. This ability is expressed in probabilistic terms, namely, the reproductive success that is expected for an organism to have (expected fitness). Yet, insofar as it is a probability, it can differ from the actual reproductive success of the organism (realized fitness). In this sense, a fitter organism has the best chance of out-surviving and out-reproducing the less fit, but it may fail to do so (Beatty & Finsen, 1989; Brandon & Beatty, 1984).

Although during the 1970s the main tendency when approaching conceptual problems in biology was epistemological and methodological, Rosenberg’s supervenient account, as well as Mills and Beatty’s propensity interpretation of fitness, can be considered metaphysical approaches to fitness. They try to clarify the ontological status of fitness as a property of organisms by using metaphysical concepts such as those of supervenience and dispositions or propensities. This metaphysical characterization of fitness, notwithstanding, was very loose. In both approaches, the mathematical form of measuring fitness seems to prevail over its ontological characterization. In Mills and Beatty’s account, for instance, fitness ends up identified with the expected number of offspring of organisms (Mills & Beatty, 1979, p. 275). In this sense, Although Rosenberg and Mills and Beatty appeal to metaphysical concepts, they do not delve into the ontological characterization of fitness that follows from the metaphysical framework they use. In fact, after Rosenberg and Mills and Beatty’s characterization of fitness, philosophers of biology continued highlighting the necessity to properly distinguish what fitness ontologically is from how it is measured (Brandon, 1990; Matthen & Ariew, 2002; Millstein, 2016).

The resource to metaphysics when addressing conceptual problems in biology is a highlighted topic nowadays, and metaphysics is used by philosophers of biology in a deeper way than the cases of fitness as a supervenient property or as a propensity

show. This can be seen in recent works oriented to improving the ontological characterization of fitness using different metaphysical resources (Abrams, 2006, 2007; Bouchard & Rosenberg, 2004; Matthen & Ariew, 2002; Triviño & Nuño de la Rosa, 2016). A recent proposal regarding the ontological characterization of fitness is the so-called causal dispositional account of fitness (Triviño & Nuño de la Rosa, 2016). This account has been developed by using the metaphysical resources given in the dispositional theory of causation (Mumford & Anjum, 2011). According to the dispositional theory of causation, causation is explained in terms of dispositional properties: once a dispositional property is triggered, a causal process begins, namely one in which the effect (i.e., the manifestation of the dispositional property) is being manifested. Entities, therefore, are able to participate in causal processes due to the dispositional properties they contain. According to Mumford and Anjum, dispositional properties rarely work alone. Rather, they can combine (either linearly or non-linearly) and work together in order to produce a certain effect. The ‘full effects’ are produced when a disposition or combination of dispositions reaches a certain threshold.

The causal dispositional account of fitness follows this metaphysical framework and characterizes fitness “as a causal disposition resulting from the non-linear combination of environmentally relative functional dispositions oriented towards an effect (surviving and reproducing) which is reached once the combination of these dispositions exceeds a certain threshold” (Triviño & Nuño de la Rosa, 2016, p. 4). The causal dispositional account of fitness offers an ontological characterization of the entity to which the concept of fitness refers (in this case, a dispositional property), and thus, serves to clarify the biological concept itself. In particular, Triviño and Nuño de la Rosa deeply explore the ontological features that can be attributed to fitness when understood from the dispositional theory of causation. Thus, they consider fitness to have the causal power of making organisms able to survive and reproduce in a particular environment and population; they explain how fitness results from the biological functional dispositions that characterize an organism; the way the fitness of an organism might vary depending on the environmental factors an organism might face; the form in which development might alter the fitness of an organism by introducing, for instance, new biological functions; the difference between the two full effects of fitness, namely the one associated to survival and the one related to reproduction, among other things.

The ontological approach to fitness by means of the metaphysical resources given in the dispositional theory of causation also offers a characterization of fitness that has some advantages over other accounts. For instance, the authors highlight that it is able to distinguish between fitness as a property of organisms, that is, their capacity to survive and reproduce; and fitness as the number of offspring, which refers to the full effect of fitness that is manifested once a certain threshold is reached. In this sense, the problems of the actualist account are solved since fitness is not identified with the number of offspring of organisms. Fitness is a dispositional causal property, and the number of offspring refers to the effect of fitness. The mismatch problem is also avoided, since the dispositional property of fitness can be manifested with different intensities in different organisms, and this intensity might not be reflected in the number of offspring an organism has. Furthermore, there are conceptual elements involved in the characterization of fitness as a causal disposition that also advocate for its



conceptual potential, such as its capacity to capture the complex and sensitive character of fitness as a disposition of organisms that is relative to a particular environment and population; and the acknowledgment of fitness as a property of organisms that might vary and is altered throughout their life-cycles: organisms might change some of the biological functions that give rise to fitness, for instance, by developing new traits (Triviño & Nuño de la Rosa, 2016).

The ontological characterization of fitness from the metaphysical framework of the dispositional theory of causation is also an illustration of a case of crossfertilization. As Triviño and Nuño de la Rosa argue, the application of the dispositional theory of causation to the case of fitness has led them to reconsider some of the aspects given in this theory. For instance, in the biological case, it is possible to consider biological functions that can dispose both towards and away from biological goals, and therefore, from fitness. Yet, this kind of dispositions is not present in the original dispositional theory of causation. In this theory there are dispositions that dispose either toward or away from a particular goal, but not to both directions at the same time (Mumford & Anjum, 2011). Furthermore, Triviño and Nuño de la Rosa highlight that the possibility of fitness to be transformed and altered over time due to the development of the organisms, as well as the consideration of the epistemological role of interfering factors, require for a reconsideration or expansion of some of the aspects of the dispositional theory of causation.

## 2.2 The case of holobionts

Holobionts are the biological entities that result from the symbiotic association between a given host<sup>3</sup> and its symbiotic microbes. These microbes might help the host to survive and perform its basic biological functions. Recently, the ontological status of holobionts has become a hot topic in philosophy of biology. It has created a great amount of controversy with regard to their individuality. Positions are divided into those who consider holobionts as real biological individuals, in the sense that it is not possible to understand biological individuals independently of the microbiota they interact with (Dupré & O'Malley, 2009; Margulis & Fester, 1991; McFall-Ngai et al., 2013; Rosenberg & Zilber-Rosenberg, 2014, 2016; Zilber-Rosenberg & Rosenberg, 2008), and those who see them as mere ecological communities (Booth, 2014; Godfrey-Smith, 2015; Queller & Strassmann, 2016; Skillings, 2016).

Recently, some authors have contributed to the debate by considering some metaphysical resources that might help to clarify the ontological status of holobionts. One example that illustrates this is the appeal to the metaphysical concept of emergence to characterize holobionts as emergent individuals that bear emergent properties (Suárez & Triviño, 2019, 2020). According to Suarez and Triviño's proposal, holobionts manifest some properties that meet the criteria for being emergent, namely dependence and autonomy. Suárez and Triviño (2020) use the property of having a sanguivory diet

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<sup>3</sup> The role of the host is played by what Maureen O'Malley and John Dupré have characterized as a 'macrobe' (animal, plant), i.e., a visible entity with a considerable degree of cellular and morphological sophistication (O'Malley and Dupré, 2007).



(present in vampire bats (*Desmodus rotundus*)) as an example of emergent property, but there are others (see Doolittle & Booth, 2017).

According to Suárez and Triviño, having a sanguivory diet is an emergent property insofar as it meets the criteria attributed to emergent properties (Wilson, 2016). Regarding *dependence*, the property of sanguivory is a property that depends on the interaction between the host bat and its microbiota. As the authors argue, the property of having a sanguivory diet is not present in the vampire bat nor in its microbiota. It is not present in the bat since its genomic adaptations do not seem to be enough to cope with all the challenges posed by sanguivory (Mendoza et al., 2018). Sanguivory is not present in the microbiota either since, although the microbiota can contribute to sanguivory, the property of being sanguivorous is not a property the microbiota possess. As the authors argue, it is the *vampire bat holobiont* the one that is sanguivorous (Suárez & Triviño, 2020). Sanguivory results from the interaction among the features present in the vampire bat's genome and the functional traits present in the microbiome that interact with the host. The property emerges from this interaction, which means that it is a dependent property.

With respect to *autonomy*, Suárez and Triviño (2019, 2020) argue that the property of sanguivory is also an autonomous one insofar as it introduces a new causal power. The authors explicitly consider Jessica Wilson's characterization of causal power. According to this account, for a property to have causal power means that the bearer of the property has the capacity to behave in a certain way once the appropriate circumstances are given (Wilson, 2016). Regarding sanguivory, the authors argue that this property allows its bearer, i.e., the vampire bat holobiont, to digest blood when the accurate conditions are given (i.e., feeding). Having a causal power, notwithstanding, is not enough for a property to be autonomous. A property with a causal power is an ontologically autonomous property (by the so-called Alexander's dictum). Yet, it might not be causally autonomous insofar as its causal power might be given in the lower-level properties upon which it depends (Kim, 2006; MacDonald & MacDonald, 2009; Wilson, 2016). In the case of sanguivory, Suárez and Triviño consider it to also be causally autonomous by arguing that its causal power is not given at lower-level parts. As they argue, the causal power of sanguivory is not present in the microbiota nor in the vampire bat host since neither of them are able to digest blood when the conditions are given. Only the vampire bat holobiont possesses the property of being sanguivorous, that is, only the vampire bat holobiont can digest blood, and thus, the property of sanguivory is introducing a new causal power into the world. Suárez and Triviño conclude that sanguivory is a strong emergent property in the sense of Wilson's, 2016.<sup>4</sup>

<sup>4</sup> Jessica Wilson distinguishes between two types of emergence: weak and strong. According to the author, a token higher-level feature *S* is *weakly metaphysically emergent* from token lower-level feature *P* on a given occasion just in case (i) *S* synchronically depends on *P* on that occasion; and (ii) *S* has a non-empty proper subset of the token powers had by *P*, on that occasion (362). On the other hand, a token higher-level feature *S* is *strongly metaphysically emergent* from token lower-level feature *P*, on a given occasion, just in case (i) *S* synchronically depends on *P* on that occasion; and (ii) *S* has at least one token power not identical with any token power of *P* on that occasion (362). According to Suárez and Triviño (2019) the causal power attributed to the property of sanguivory is not a subset of the token powers had by the host and the microbiota. As they claim, sanguivory is a higher-level property that introduces a new causal power into the world, namely the power to allow its bearer (i.e., the vampire-bat holobiont) to digest blood. This causal

The resource to the metaphysical notion of emergence allows for the clarification of the ontological status of holobionts. In this sense, Suárez and Triviño argue that, insofar as the vampire bat holobiont bears the emergent property of sanguivory, it must be an emergent individual.<sup>5</sup> This metaphysical characterization of holobionts has some advantages over the characterization of holobionts as ecological communities, such as the possibility to explain the etiological origin of some adaptive traits. In this regard, the authors argue, the reason why these traits have not become extinct “lies in their contribution to allow the existence of a particular phenotype in the holobiont (sanguivory, herbivory, niche adaptations, etc.), rather than in their contribution to the fitness of the bacterial taxa that bear them” (Suárez & Triviño, 2020, p. 12).

Both the case of fitness and the case of holobionts are examples of the mode of doing Metaphysics of Biology that I have called *Metaphysics for Biology*. As it has been illustrated, in *Metaphysics for Biology* the focus is mainly on metaphysical theories and concepts, exploring the way these metaphysical resources can be used to ontologically characterize the entity to which a biological concept refers. In the case of fitness, the metaphysical resources employed are those of the dispositional theory of causation, that allow for a characterization of fitness as a causal dispositional property of organisms. In the case of holobionts, the metaphysical resources used are those offered by the theories about emergent properties. Thus, holobionts are characterized as emergent individuals that bear emergent properties. The key point of this form of doing Metaphysics of Biology is that by clarifying the ontological status of the entity to which the biological concept refers, the biological concept itself is clarified. In the case of fitness, the causal dispositional account helps to explain what fitness is, avoiding confusions between its definition and the way it is measured. In the case of holobionts, their characterization as emergent individuals shed a new light on the current debate regarding their consideration as individuals or ecological communities.

### 3 Metaphysics in Biology

Besides the clarification of the ontological status of the entities to which biological concepts refer, there seems to be a different way philosophers of biology recur to metaphysics, what I have called *Metaphysics in Biology*. In this case, philosophers explore and make precise the metaphysical commitments and implications that can be found in biology. In this kind of cases, philosophers of biology pay attention to biological theories, phenomena, and practices in order to disentangle the metaphysical commitments and assumptions that are given in them. In doing so, philosophers of biology are able to clarify and shed light on the biological theories, phenomena, and practices themselves.

This form of doing Metaphysics of Biology is different from the one introduced in the previous section. As we have seen, in *Metaphysics for Biology* philosophers

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Footnote 4 continued

power, the authors argue, is not identical with any of the token powers of the properties that characterize the host and the microbiota.

<sup>5</sup> It is emergent, the authors argue, because in metaphysics it is considered that the bearers of emergent properties are emergent entities (Bedau, 1997).

address conceptual issues in biology by appealing to metaphysical theories and concepts that can help to clarify the ontological status of the entities biological concepts refer to. In *Metaphysics in Biology*, notwithstanding, philosophers pay more attention to the biological theories, phenomena, and practices in order to highlight the ontological commitments that might follow from them.

Different examples in the literature can serve as illustrations of *Metaphysics in Biology*. In this section, I will divide them into three categories, namely those referring to the ontological implications that follow from biological theories; those that refer to the case of biological phenomena; and, finally, those based on the ontological implications that can be obtained from the biological practice.

### 3.1 Ontological implications of biological theories

Concerning the ontological implications and consequences given in *biological theories*, Darwin's theory of evolution by natural selection has been a major focus of interest among philosophers of biology. Some of the possible ontological implications and consequences of this theory explored in the literature refer to the question about the existence of final causes in biology (Mayr, 1982), the deterministic or stochastic status of evolution by natural selection (Bouchard & Rosenberg, 2004; Brandon & Carson, 1996; Graves et al., 1999; Horan, 1994; Rosenberg, 1994; Weber, 2001), or the ontological status of species as individuals instead of classes (Ghiselin, 1974; Hull, 1978).<sup>6</sup>

In this section, I recur to the philosophical work on holobionts to exemplify this form of doing *Metaphysics of Biology*. In doing so, the previous consideration about the question of emphasis can also be illustrated (see Sect. 1). In this sense, recall that there are no *Metaphysics for Biology* problems and *Metaphysics in Biology* problems. A problem will be of one type or another depending on how the philosopher is approaching it. Regarding holobionts, in this case, I will consider recent studies that have focused on exploring the ontological implications that follow from a particular theory, i.e., the eco-immunity account of the holobiont (Chiu & Eberl, 2016).

The eco-immunity account is grounded on two recent theories on immunity, namely the Discontinuity Theory and the Equilibrium Model. According to *the discontinuity theory*, the immune system of an organism establishes the conditions that determine what constitute it, i.e., its constituent parts (*criterion of inclusion*), and the conditions in which the organism is actively maintained in the face of constant external perturbations (*criterion of persistence*) (Chiu & Eberl, 2016, p. 822). According to *the equilibrium model*, immunity should be conceived of in terms of the types of reactions that are triggered as a response to three different kinds of targets that the immune system faces, namely intracellular signals -from virus and some bacteria; small extracellular signals

<sup>6</sup> Regarding this debate, different ontologies have also been proposed besides that of classes and individuals, such as species as sets (Kitcher, 1984) -in which species might be both spatiotemporally restricted set of organisms, i.e. individuals; or spatiotemporally unrestricted sets of organisms, i.e. groups of organisms that share structural similarities such as genetic, chromosomal and developmental similarities; or species as homeostatic property cluster kinds (Boyd, 1999a, b; Griffiths, 1999; Millikan, 1999) -in which species are groups of entities that share common properties or stable similarities that are not, in fact, essential for the membership in that species.

-from helminths and tissue injuries; and large extracellular signals -from fungi and most bacteria (Eberl, 2016). These three types of immunity are differentiated by the location, size and general kingdom of the microorganisms' signals and the host's injury signals (Chiu & Eberl, 2016, p. 824). Furthermore, insofar as all of the three kinds of stimuli are constantly and simultaneously present, the immune system never rests but is continuously responding to the different stimuli it is exposed to (Chiu & Eberl, 2016, p. 825). However, only one kind of response prevails over the others depending on the kind of infection or injury. In this regard, the kind of response that prevails inhibits the effects of the others such that the immune responses are 'downregulated' (Chiu & Eberl, 2016, p. 825).

The regulated mutual inhibition of the immune system to the stimuli is responsible for the persistence and health of the host. The complete inhibition of one kind of response as well as the constant prevalence of one of them over the others can produce important damages in the organism, compromising its health and persistence. Consequently, there needs to be a kind of balance among the three classes of responses to stimuli in order for the organism to persist. In Chiu and Eberl's view, the microbiota, together with the immune system of the host, allows the persistence and individuality of the host itself (Chiu & Eberl, 2016, p. 820). The immunity system allows for the host individuality insofar as it determines the constituents of the host. In this regard, insofar as microorganisms interact with the immune system of the host, they also allow for its individuality and persistence (Chiu & Eberl, 2016, p. 829).

However, despite claiming that immunity allows to establish the individuality of the host by determining its constituents, and although the host immunity is also activated by microorganisms, Chiu and Eberl do not consider microorganisms as constituents of the host. In the eco-immunity framework, microorganisms are *scaffolds* of the host individuality, insofar as they allow for appropriate development of the host (the scaffoldee) by increasing the quality, efficiency, and stability of its developmental processes. Furthermore, microorganisms also favor and sometimes control the maintenance of the immunological system of the host, as well as its proper functioning, including how and when it is activated. In this sense, the microorganisms are *resources* that instantiate and regulate the immunological capacities and processes necessary to determine the constituency of the host, and they do so in a way that allows its persistence.

Chiu and Eberl appeal to the biological criteria of inclusion and persistence (Pradeu & Vivier, 2016) and offer two arguments to show that the microbiota is not a proper part of the host, namely: absence of causal-functional integration; and changeability (see Triviño & Suárez, 2020).

Regarding the first argument, Chiu and Eberl argue that microorganisms are not proper parts of the host since they are not causally-functionally integrated with it. According to the authors, although there are cases wherein microorganisms are believed to be indispensable and highly integrated into the development, metabolism, adaptation, and reproduction of the host, these cases do not show that microorganisms are proper parts of the host: "these fascinating cases at most dispel the notion that macroorganisms are self-sufficient without microorganisms. They fall short of showing that holobionts are causally integrated metabolic or reproductive wholes" (Chiu & Eberl, 2016, p. 821). For Chiu and Eberl, the possibility for some microorganisms to have *negative* or *no effects* on the host phenotype and its reproduction is sufficient

for discarding them as being functionally integrated with the host, and therefore, as being proper parts of it.

With respect to changeability, Chiu and Eberl offer different arguments to show that the species of microbiota that interact with a particular host of a given species are changeable, and thus, they argue, that the microbiota cannot be considered as a proper part of the host. In particular, the authors offer two main arguments to illustrate this changeable character of microbiota (Chiu & Eberl, 2016): (1) contingency, according to which the *species* of microbiota that bring about some of the processes of the host, such as its development, might differ among *different hosts* of the *same species*; and (2) interchangeability, that refers to the possibility for a species of microbiota that interact with a particular host to vary during the lifetime of the host.

Triviño and Suárez (2020) have recently explored the metaphysical implications and commitments regarding the notion of parthood that are implied in the eco-immunity account. In doing so, the authors recur to metaphysical accounts regarding mereology, parthood, as well as persistence, and offer counterarguments to Chiu and Eberl's proposal. In this sense, with respect to the lack of causal-functional integration, the authors argue that organs are considered to be proper parts of the host, and there does not seem to be any problem in accepting that there might be organs with deleterious functions or with no functions at all. The appendix, for instance, does not have a clear function. Furthermore, cases of malfunction are widely acknowledged in the literature (Millikan, 1989; Mossio et al., 2009; Saborido, 2013). As Triviño and Suárez argue, a pancreas might not produce enough insulin to properly regulate the levels of sugar in an organism. Yet, in cases of malfunction, the organ is still considered to be a proper part of the host.

The authors also explore the metaphysical assumptions and implications that are given in Chiu and Eberl's arguments regarding the changeable character of the microbiota. The core idea of their responses to the arguments of contingency and interchangeability is that proper parts of an object can change, and metaphysical theories of persistence and change, such as three-dimensionalism and four-dimensionalism, are trying to explain how. Thus, regarding contingency, Triviño and Suarez claim that although Chiu and Eberl are right to observe that the particular species of microorganisms that interact with the hosts of a given species are highly variable and depend on various external conditions, such as environmental pressures, kinds of social relationships of the host, diet, etc.... the contingency of the microbiota does not seem to entail that it is not a proper part of the host. To establish parthood relations, it is not relevant that both hosts belong to the same species, that is, what is a proper part of one host is independent of what is a proper part of a different host. In this case, as long as the microbiota is playing a particular function within the host, it is part of it, regardless of whether there is a different species of microbiota that is playing the same function for a different host of the same species.

Regarding the interchangeability of the microbiota, besides appealing to metaphysical theories of persistence in order to explain why the microbiota can be a proper part of the host at least during the particular interval of time during which it is interacting with the host, Triviño and Suárez also explore some conclusions that follow from Chiu and Eberl's argument and that are difficult to accept, namely that organs are not proper parts of the host. If Chiu and Eberl's criterion of parthood is accepted, then one needs to

assume that organs are not proper parts of the host insofar as they can be transplanted. As the authors argue, “It seems counterintuitive to deny organs their status as proper parts of us on the basis that they are interchangeable by other structures, or to deny the new structures their role as proper parts of us once they have been transplanted. By analogy, therefore, it does not seem accurate to deny microorganisms that compose the microbiota their status as proper parts of the holobiont on the basis that they are highly inter-changeable [...]” (Triviño & Suárez, 2020, p. 6).

The general idea behind Triviño and Suárez’s arguments is that it is unclear in Chiu and Eberl’s account why microorganisms deserve different treatment than other proper parts of the body such as organs. In fact, by rejecting the causal-functional integration of the microorganisms with the host, Chiu and Eberl seem to apply two different criteria of parthood for the different entities that compose the holobiont, namely microorganisms and the zygotically-derived components of the host. However, it is not clear why this has to be so: what is exactly the reason why the criterion of parthood that would apply to a malfunctioning pancreas, a transplanted organ, or an appendix would not equally apply to the persistent elements of the microbiota?

The case of the eco-immunity account and its replies is an example of *Metaphysics in Biology*. In this case, the eco-immunity account of holobionts has been considered in order to explore the metaphysical assumptions and implications that are given in it regarding the notion of parthood. As Triviño and Suárez conclude, Chiu and Eberl’s account implies a notion of parthood that is problematic, and the arguments they offer to reject the microbiota to be a proper part of the host are not well metaphysically grounded.

### 3.2 Ontological implications of biological phenomena

Philosophers of biology have also paid attention to metaphysical implications and consequences derived from *biological phenomena*.<sup>7</sup> In this regard, the debate on whether biological entities are better understood as processes or substances has become a core concern among philosophers of biology in the last few years. Although substance ontology, according to which substances are the primary units of reality, has been the predominant one in Western philosophy (Seibt, 2016), advances in evolutionary and developmental biology (Baptiste & Dupré, 2013; Nuño de la Rosa, 2013; Austin, 2016a), as well as the study of some aspects of biological entities, such as developmental plasticity, robustness, or the different forms and properties that characterize organisms during the different stages of their life cycle, have recently been used to claim that biological entities are not ontologically substances but processes (Dupré, 2012, 2015; Nicholson & Dupré, 2018), that is, dynamic entities that are continuously

<sup>7</sup> In this regard, a reviewer asked me to clarify the notion of ‘implications’ since it is rare to claim that biological phenomena have ontological *implications*. The reviewer is right in considering that ‘implications’ seem to be a notion mainly associated with propositions. In this case, the idea is to highlight that philosophers of biology are trying to reveal or clarify the ontology of the biological phenomena, that is, how biological entities are. In doing so, they pay attention to some biological phenomena and explore whether these phenomena are better explained if we consider biological entities as substances or processes. It is in this sense that I have considered that ontological implications (regarding the living beings) are given from the study of biological phenomena such as development or plasticity, among others.

changing (Seibt, 2016; see also Baptiste & Dupré, 2013, pp. 380–381). In particular, Dupré argues that biological entities are better understood as “a hierarchy of deeply intertwined processes, processes that are shaped by both higher and lower level processes with which they are connected” (Dupré, 2015, 34).

Although it is considered that biological entities are better understood if conceived as being processes (Nicholson & Dupré, 2018), the debate between substantialists and processualists is not over. Thus, some authors have recently argued that the biological aspects that are used to argue for a process ontology (such as plasticity, robustness, development...) can also be explained in terms of a substance ontology (Austin, 2016b). The debate between substantialists and processualists is an important current one. Yet, the main point I want to highlight in this section is that the upholders of both positions are obtaining metaphysical conclusions by paying attention to the biological entities and, in particular, to the features and behaviors that characterize them. In this sense, we can talk about a case of *Metaphysics in Biology*, since philosophers of biology explore the ontological commitments and implications that follow from the biological features they see and study.

### 3.3 Ontological implications of biological practices

Besides biological theories and phenomena, philosophers of biology also pay attention to the *biological practice* and the metaphysical implications given in it. Currently, there is a shift from a theory-based to a *practice-based metaphysics*. This new approach advocates the idea that it is possible to get some access to the structure of reality by focusing on scientific practices (Waters, 2017). In this view, it is assumed that scientific practice develops as it does because reality imposes some restrictions on it. Although this practice-based metaphysics has been generally developed in relation to physics, some examples of this kind of approach in biology can be found as well. Robert Brandon, for example, pays attention to the practice of evolutionary biology and concludes that there are no ‘lawlike regularities’ in this field, but only contingent ones. In this regard, he claims that:

I am going to argue that the character of experimental evolutionary biology can best be made sense of if we see much of it as being an exploration of *contingent regularities*. [...] I will argue that biologists are interested in contingent regularities, not for some purely sociological reason, but because of the nature of the evolutionary process. [...] experimental evolutionary biology has the character it has because evolution produces contingent regularities (Brandon, 1996, pp. S444–S445).

In the same line, Waters has recently appealed to the use of the concept of ‘gene’ in contemporary genetics in order to explore the ontological implications that can be derived from it. In particular, he claims that:

Examining how the [molecular gene] concept is employed in practice reveals that it is not a category of being that “cuts nature at its joints”. The problem with using this metaphor is that DNA has too many joints. [...] *the practice of genetics*



*utilizes a flexible gene concept because there is no overall structure, functional or causal, of the elements of DNA* (Waters, 2017, p. 83. Emphasis added).

Finally, another example of a biological practice-based metaphysics can be found in the work of Thomas Reydon (2005, 2008), who has studied the ontological implications of biological practices in different disciplines, such as evolutionary and systematic biology. Particularly, he focuses on the use of the term ‘species’ in the scientific practice of these disciplines and concludes that the concept refers to two different ontological entities, namely: *evolverons* and *phylons*. *Evolverons* are dynamic entities that participate in the evolutionary process and interact with their environment and with other species as cohesive units. For Reydon, these are the entities referred to by the term ‘species’ in evolutionary biology since this discipline aims at explaining the evolutionary causal mechanisms. *Phylons*, notwithstanding, are static entities that result from the evolutionary process. They refer to phylogenetic lineages constituted by relations of common descent. According to Reydon, they are what biologists in systematic biology call ‘species’ since they are used to classify the biodiversity of the organic world due to their stability through time and their mutual exclusion.

In all these cases, i.e., those about contingent regularities, genes, and species, the authors are obtaining and establishing conclusions regarding the ontology of the biological world by paying attention to the biological practice. In this sense, it is possible to claim that a form of doing Metaphysics of Biology, namely Metaphysics *in* Biology, is taking place since the metaphysical consequences and implications that follow from the biological practices are explored.

The case of Reydon’s approach to the characterization of the term ‘species’ in the different biological practices of evolutionary and systematic biology can also serve to illustrate a case of crossfertilization. In his proposal, Reydon also explores the form *evolverons* and *phylons* persist. In doing so, he appeals to the contemporary theories of persistence of endurantism and perdurantism and argue that *evolverons* persist by endurance while *phylons* persist by perdurance. According to Reydon, endurance is the way synchronic entities persist. In this account, persistence occurs because the entity is wholly present at each time at which it exists. For Reydon, *evolverons* are synchronic entities. They are constituted by living organisms since these are the ones that are able to participate in the evolutionary process due to their interactions (reproduction, mating, competition...). Regarding perdurance, Reydon considers this to be the form in which diachronic entities persist. In this case, diachronic entities are not wholly present, but they are extended in time: they persist by having different temporal parts manifested at different times at which they exist. For Reydon, *phylons* are diachronic entities. Since systematic biology deals with the classification of *all* organisms of all times, the organisms constituting them must exist at times very distant in the history of life. Unlike *evolverons*, *phylons*, due to their classificatory role, are constituted by both living and dead organisms (Reydon, 2008).

Reydon concludes that, due to their synchronic and diachronic aspects, *evolverons* and *phylons* respectively persist by means of endurance and perdurance. This conclusion in philosophy of biology regarding the ontology and persistence of species also affects the metaphysical theories and concepts initially considered by the philosopher,

namely those of endurantism and perdurantism. Reydon is aware of the crossfertilization given in this case. He states that conceiving of *evolverons* and *phylons* as persisting by endurance and perdurance, respectively, allows us to shed light on the metaphysical debate concerning the equivalence between both theories of persistence. According to some metaphysicians, both theories of persistence, endurantism and perdurantism, are not different theories insofar as they are equivalent, that is, insofar as intertranslation between both theories can take place without loss of information (see McCall & Lowe, 2003, 2006; Miller, 2005, 2010). In Reydon's view, notwithstanding, the ontological consideration of species as enduring and perdurant entities illustrates that such equivalence does not really hold (Reydon, 2008). Since *evolverons* are constituted only by living organisms, whereas *phylons* are constituted by both living and dead organisms, it is not possible to intertranslate between both forms of persistence without losing information. Thus, Reydon concludes that: "For the species debate, the conclusion must be that the position that species [endurantism] and species [perdurantism] constitute metaphysically equivalent theories is not a feasible choice. Note that the above consideration also shed some doubt on the general [endurantism/perdurantism] equivalence claim. The [endurantism/perdurantism] equivalence claim does not hold in the case of species, so it does not hold in general" (Reydon, 2008, p. 177).

As we see it, this case is an example of crossfertilization insofar as the metaphysical theories initially used, such as endurantism and perdurantism, are reconsidered due to their application to a particular case in philosophy of biology. In particular, from Reydon's arguments, it is the thesis of equivalence between endurantism and perdurantism that needs to be put in jeopardy. Yet, there are other authors that have argued that the case of *evolverons* and *phylons* is not a case against the equivalence thesis (see Triviño & Cerezo, 2015).

## 4 Conclusions

In this paper, I have paid attention to different cases in which philosophers of biology appeal to metaphysics when addressing conceptual or theoretical biological problems. In doing so, I explore the way they use the metaphysical resources they consider, and therefore, the way Metaphysics of Biology can be done. In this regard, I propose a categorization of two different ways Metaphysics of Biology take place, namely Metaphysics *for* and Metaphysics *in* Biology. In Metaphysics *for* Biology philosophers appeal to metaphysical theories and/or concepts in order to elucidate the kind of ontological reality biological concepts refer to. In this way, the conceptual issue at stake in biology is clarified. In Metaphysics *in* Biology, on the other hand, philosophers of biology pay attention to biological theories, phenomena, and practices, in order to explore the metaphysical implications and consequences that might be given in them. In doing so, the philosopher of biology helps to shed light on the biological theories, phenomena, and practices themselves.

Although both forms of Metaphysics of Biology can be seen in the different examples I have presented, the distinction between Metaphysics *for* and Metaphysics *in* Biology is not a sharp one in the sense that there are no Metaphysics *for* Biology problems and Metaphysics *in* Biology problems. Generally, the question about whether a

particular case study is a form of Metaphysics *for* or Metaphysics *in* Biology, is a question of emphasis. That is, it will depend on whether the philosopher is placing the emphasis on the metaphysical theories and concepts, or whether she is focusing on the biological theories, phenomena, and practices. Besides the questions of the emphasis, in Metaphysics of Biology cases of crossfertilization can also take place, as it has been shown with the case of fitness in Metaphysics *for* Biology, and the case of the species in Metaphysics *in* Biology.

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## Declarations

**Conflict of interest** The author declares that she has no conflict of interest.

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