

‘The Ontology of the Holobiont’

The aim of the project

The aim of the project is to defend the idea that symbiotic microorganisms are more like host cells than like elements of the environment. Therefore, the project aims to deliver the ontology of the holobiont, the symbiotic ‘furniture of the world’, to show how elements of the living world should be classified within the holobiont paradigm.

Funding of the project

For this study, it is assumed that funding is to be obtained through a research non-fungible token (rNFT) which would constitute the sole source of funding of the project ‘The Ontology of the Holobiont’. Reference to this rNFT will be listed in the scientific paper to be written as an outcome of the project. By buying the rNFT, you will be funding the project. You can buy the rNFT [here](#).

To learn more about research non-fungible tokens (rNFTs), read [here](#).



Summary of the project

Imagine that your body is covered with a vast number of microorganisms, occupying every part of your body and responsible for performing a variety of functions. In fact, it's not necessary to *imagine* this, because this is actually what science teaches us about multicellular organisms. Humans, plants, animals, etc., harbour communities that can be found within and on their bodies. These communities perform a variety of functions that years ago were ascribed to their multicellular hosts, such as defence against pathogens and digestion of nutrients (e.g. Sekirov et al. 2010; Shreiner et al. 2015). Multicellular organisms, in combination with their symbiotic microorganisms, constitute **holobionts** – multi-species beings (Gilbert et al. 2013; Zilber-Rosenberg and Rosenberg 2008).

This idea of the holobiont has been very popular in recent years among scholars from the empirical perspective. Every day we learn something new about symbiotic microorganisms and their relationship to their multicellular organisms. Let me just give you a few examples from the last months. For instance, very recently, Ruuskanen et al. (2021) suggested that there is a link between gut microbiome composition and fatty liver disease. Then we have Boehme et al. (2021), who showed that, in mice, the transplant of microorganisms (faecal transplantation) from young donors reverses some aspects of brain aging in older recipients. In another paper, Braun et al. (2021) showed that SARS-CoV-2 has no substantial effect on nasopharyngeal microbial composition, which, as the authors noted, is surprising, because other viruses have such an effect. To give just one more example, von Schwartzberg et al. (2021) showed that a very low-calorie diet changes the composition of symbiotic microorganisms in humans, resulting in an increase in the specific bacteria *Clostridioides difficile*, which is associated with antibiotic-induced diarrhoea and colitis.

Philosophical elaborations are also taking place in this field. One such elaboration concerns the question of individuality. Concerning the debate about biological individuality, Pradeu

(2016a) stated that ‘[...] asking what a biological individual is means asking what constitutes a countable, relatively well-delineated, and cohesive unit in the living world’. Holobionts appear relevant to this debate, because their existence forces us to ask whether microbes should be regarded as a part of individuality. Of course, there are multiple concepts of biological individuals; thus the answer quite often depends on the concept in question. For instance, Pradeu (2016b) has argued that, in terms of the physiological concept of individuality, at least some microorganisms should be considered part of our individuality. Gilbert et al. (2013) have taken an even more progressive stance, stating that research on symbiotic organisms is changing every concept of the organism present in biology. Others have defended the idea that holobionts, from the evolutionary perspective, are more like ecosystems than organisms (Douglas and Werren 2016; Skillings 2016), while others put forward the idea that they are evolutionary individuals (Zilber-Rosenberg and Rosenberg 2008). My colleague Suarez and I (2020) argued that the holobiont is changing our philosophical idea of individuality and that we should accept the idea that something can be – at least in the context of the physiological concept of individuality – both an individual and ecosystem.

Overall, research on the holobiont has an impact that transcends the boundaries of biology and influences the humanities. Some argue that its influence may even extend to the arts (Rees et al. 2018) – and clearly it does! For instance, references to the holobiont appear in a new collection of essays by the famous Polish Nobel laureate Olga Tokarczuk (2020, p. 15):

Jesteśmy już nie tyle biontem, ile holobiontem, czyli zespołem różnych organizmów żyjących ze sobą w symbiozie. Złożenie, wielość, wzajemne oddziaływanie, metasymbioza - to nowe perspektywy, z których oglądamy świat.

We are no longer a biont, but a holobiont, that is, a group of various organisms living together in symbiosis. Complexity, multiplicity, interaction, metasymbiosis – these are the new perspectives from which we view the world.

However, a great many issues are still unsolved, and empirical and philosophical research is continually encountering new problems. In the course of this project I wish to investigate one such philosophical problem. One reason people are not happy with the idea that we are some sort of multi-species beings, or holobionts, stems from their belief that microbial cells are more similar to substances such as oxygen or water than they are to our own cells, and thus should be considered part of the environment. In other words, the fact that we depend functionally on our microbiota does not mean that they are part of us, just as we don't consider gravity or oxygen from the air to be part of us (e.g. Moran and Sloan 2015, Chiu and Eberl 2016, Douglas and Werren 2016, Skillings 2016 Bourrat and Griffiths 2018). Others counter these arguments, stating that symbiotic microorganisms are more like host cells (Clarke et al. 2014, Bordenstein and Theis 2015, Stencel and Proszewska 2018, Triviño and Suárez 2020, Boem et al. 2021). Some even call symbiotic microorganisms, viewed as a whole, 'the forgotten organ' (Clarke 2014). This raises the question: which view is correct?



The aim of the project is to evaluate the ontological status of symbiotic cells found within holobionts and to compare them with the cells of multicellular organisms and with what are commonly considered elements of the environment to decide whether they more closely resemble the former or the latter. I will defend the idea that they are more like host cells. To achieve this aim I will evaluate each of the arguments that have been put forward (from both sides of the debate) as well as developing new arguments. Therefore, the project aims to determine the ontology of the holobiont, the symbiotic ‘furniture of the world’, to show how elements of the living world should be classified within the holobiont paradigm.

Significance of the project

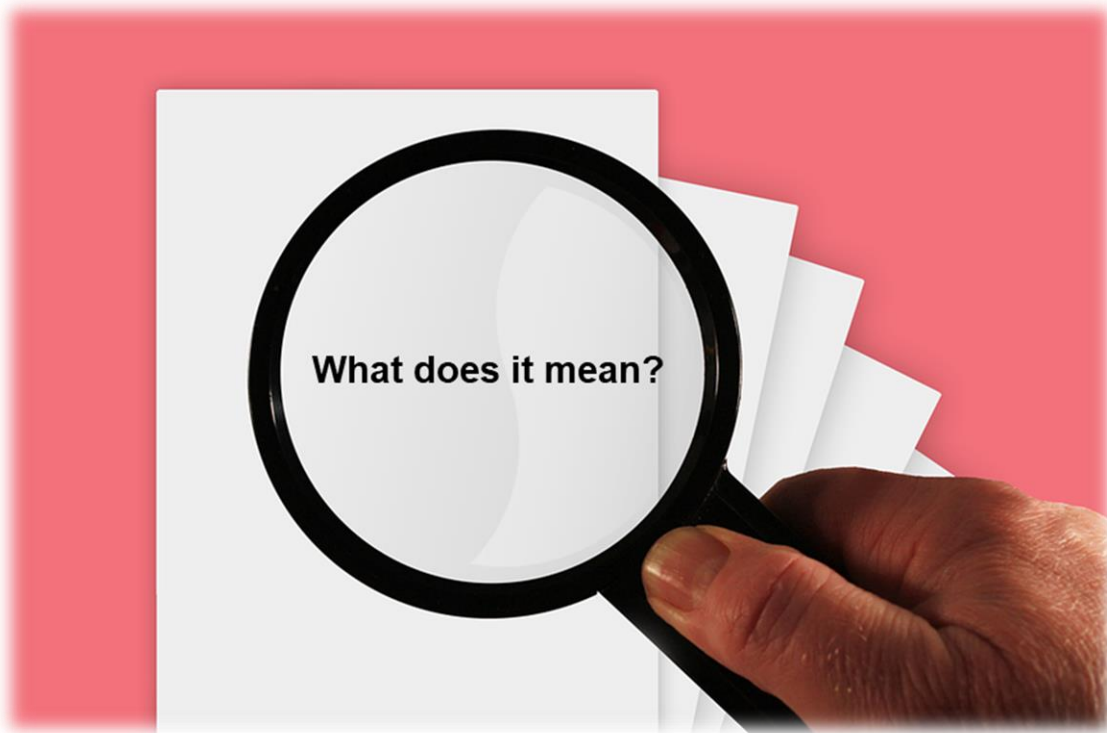
The project will contribute to our understanding of the nature of the holobiont, which itself is, in philosophical terms, a very interesting idea. However, the project may make an additional contribution to the debates concerning the holobiont. By determining whether symbiotic cells are more like host cells than environmental factors, the outcome of the project may contribute to the long-standing debate on the organismality of holobionts, which aims to determine whether holobionts are organisms or ecosystems of a sort (for different approaches, see Gilbert et al. 2013; Zilber-Rosenberg and Rosenberg 2008; Moran and Sloan 2015; Skillings 2016; Triviño and Suárez 2020; Suárez and Stencel 2016), since researchers working on this issue frequently raise arguments which equate symbiotic cells with environmental factors. Another area of potential contribution is the study of speciation, for which some have suggested that symbiotic microorganisms may be responsible (e.g. Sharon et al. 2010; Brucker and Bordenstein 2013), while others have questioned this idea (e.g. Chandler and Turelli 2014; Leftwich et al. 2017). By determining the ontological nature of the holobiont, the project may provide additional motivation to think of symbiotic microorganisms as speciation agents.



The above examples represent just the tip of the iceberg, since the debate on the holobiont influences many more issues in biology. Therefore, determination of the ontological nature of symbiotic microorganisms may contribute to the solution of many scientific and philosophical debates. Additionally, I believe that revelation of the ontological nature of the holobiont may contribute to a more widespread understanding of human beings as multi-species units, which may cause the concept of the holobiont to exert even greater influence on the culture that it does at present.

Methods of investigation

The project is located at the intersection of philosophy and biology. Even though the main task of the project appears to be biological in nature, it is clearly the type of question pursued by philosophers, i.e. a matter of presenting arguments in favour of a given position. Here we have a question about the classification of symbiotic cells. Should we classify them as being more similar to host cells or to the cells' environment? Here I will try to gather arguments in favour of the former position. To do so, I will employ two main methods.



The first is based on analysis of scientific practice, in order to identify the assumptions scientists make in arguing that symbiotic cells are either like elements of the environment or like cells of the host. This analysis will be conducted by means of a careful examination of the research studies that have led scientists to certain conclusions about the nature of symbiotic cells. This will enable me to discover the specific assumptions and ideas that have led them towards certain interpretations. The second method is conceptual analysis. I will examine not only scientific practice, but also the nature of the concepts scientists use in this practice. I will analyse these concepts in order to clarify what, in a given case, their thinking has been. This will enable me to understand the relevant scientific practice and thus better understand the ontological nature of symbiotic cells. The methods I will use for these investigations are not new. Philosophers have been systematically involved in scientific debates and have contributed to solving many issues (see Laplane 2019; De Haro 2020).

Budget of the project

I am not specifying an exact budget, since this is a pioneering way to obtain research funds for an philosophical research project (concerning the use of NFTs for replication [click](#)). The money will be used for linguistic editing, open access, research expenses, and conferences. If I am successful in raising additional funds, I will organise a conference on the topic and invite specialists to Krakow. The project will be undertaken no matter how much money I raise.

Duration of the project:

October 2021–October 2022

Output of the project:

The output of the project will consist of one paper published in the Open Access mode.

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Images used for preparing the full project and highlights: Pixbay, public domain vectors

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