

Project Report

How Will the Emerging Plurality of Lives Change How We Conceive of and Relate to Life?

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Abstract: The project “A Plurality of Lives” was funded and hosted by the Pufendorf Institute for Advanced Studies at Lund University, Sweden. The aim of the project was to better understand how a second origin of life, either in the form of a discovery of extraterrestrial life, life developed in a laboratory, or machines equipped with abilities previously only ascribed to living beings, will change how we understand and relate to life. Because of the inherently interdisciplinary nature of the project aim, the project took an interdisciplinary approach with a research group made up of 12 senior researchers representing 12 different disciplines. The project resulted in a joint volume, an international symposium, several new projects, and a network of researchers in the field, all continuing to communicate about and advance the aim of the project.

Keywords: Life; definition of life; extraterrestrial life; synthetic life; artificial intelligence

1. Introduction

Research groups around the world are currently busy trying to invent new life in the laboratory and looking for extraterrestrial life (see e.g., References [1–8]). Furthermore, new developments in artificial intelligence (AI) and robotics means machines are approaching a degree of autonomy that until now has been restricted to living beings (see e.g., References [1,9,10]). These areas have one thing in common, namely that they might, within our lifetime, provide us with what can be termed a second origin of life; that is, life that is not related to life as we know it today.

A few decades ago, both the creation of new life and the discovery of extraterrestrial life would have been seen as science fiction. Today, the scientific community generally agrees that it is a question

of when, not if, any of these endeavors will be successful. Despite this, there are reasons to believe that we are ill-prepared for the challenges, as well as the opportunities, that the emergence of a plurality of lives—life forms with different origins—undoubtedly will create.

The emergence of a plurality of lives will have profound effects on a wide range of issues that all depend on how we look at life; from how to frame research questions in chemistry, biology, and astrobiology through legal and political questions, to philosophical and theological perspectives. Only a thoroughly interdisciplinary approach can tackle the basic question behind all these challenges; that is, how will the emerging plurality of lives change how we understand and relate to life?

2. Background

What it means to be alive is a question that can be approached from many different perspectives. It remains central in many contemporary research projects, most obviously in biology, astrobiology, and chemistry, but also in medicine, theology, and philosophy, not to mention in many works of literature, film, and art. Life and its limitations has inspired numerous novels, poems, films, and other works of art, as well as countless scientific endeavors. The phenomenon we call 'Life' is simply fundamentally different from all other phenomena, and we still have to figure out exactly how.

That life is such a multifaceted phenomenon makes it captivating to both scientists and the wider public. This is also part of the challenge, since it means that understanding life and its frontiers is a genuinely interdisciplinary task that has to take into account some deep human intuitions, as well as the latest findings in science and the latest innovations in technology and medicine. It is not possible to capture the full extent of what makes life special and how it differs from non-life with only the tools and methods of a single discipline. So far, there have been many attempts to understand the concept of 'Life' from many different disciplinary perspectives, and it is usually assumed that a definition of life has to take the form of a list of necessary properties [11–17]. Among the properties that are usually listed, some focus on typical biological properties such as evolution [14,18–22] or reproduction [20,22,23]. Others focus on chemical composition [21,23–25] or biochemical properties [26]. The physicist Erwin Schrödinger defined life in terms of entropy [27], while some want to focus on the acquisition and use of information [13,28] or energy [29]. Most authors try to combine different types of properties in order to produce a sufficient set of necessary properties, but the result is typically multi- rather than inter-disciplinary (see e.g., References [21,30]).

The existence of countless studies carried out from different perspectives does not automatically provide an inter-disciplinary understanding, however. It is similar to the old tale of a group of people standing in a dark room with an elephant. They all feel different parts of the elephant: a leg, the trunk, an ear, a tusk, and so on. Their descriptions of the animal in front of them will therefore be very different, and they will not be able to get a complete picture of the animal. Instead, they continue to argue and each of them defends their own perspective. This very much resembles the present discussion about the nature of life. To take the next step, representatives from different disciplines need to go beyond simply contributing their own suggestions based on their own perspectives, and instead work actively together in a joint effort, and with open minds. In this project, we took the latter approach by applying a methodology based on Ludwig Wittgenstein's concept of family resemblance [31]. This is an approach that has so far only been suggested, but never actually tried [32–35].

The project was hosted and funded by the Pufendorf Institute for Advanced Studies (PIAS) at Lund University (<https://www.pi.lu.se/>) and carried out during the academic year 2016–2017. The mission of the PIAS is to initiate new interdisciplinary approaches and research constellations that deal with questions of high societal relevance, which cannot be dealt with in a satisfactory way within just one or a few adjacent disciplines. Projects funded by the PIAS are thus not primarily judged by their ability to immediately generate concrete answers to research questions, but by their ability to generate new interdisciplinary constellations and fundable research project ideas that in turn will produce cutting-edge research that might not otherwise have been initiated.

3. Practical Implications

A second origin of life will in a stroke change how we look at life. By providing an instance of life that is not related to us, it will help us deal with the question of whether something is a necessary criterion for life, or just happens to be a universal property of life as we know it today. It will therefore be invaluable for our attempts to understand life. A second origin of life will thus affect how we define life, but also our attitudes to life, and perhaps even how we live our lives [36–42]. This in turn will have many practical implications that need legislation and policy decisions [43–47]. In a nutshell, it might be one of the most revolutionary events in the history of our species, and it may well happen within our lifetimes.

The fact that the new life is discovered or invented by a human (or an organization of humans) might affect how we value it, and it will most certainly invite discussions about its legal status. Life as we know it is an object of both governance and regulation, and the subject from which such regulation departs [48]. The prospect of a plurality of lives makes for problematic basic assumptions in both these aspects. Some of the vital questions that may be posed are to what extent we accept the technologically possible, and the procedures through which political decisions are made with respect to questions of new forms of life [49]. The possibility of discovering or inventing new forms of life is based on particularly advanced technical and scientific knowledge, involving experts from many domains. As with all complicated areas, policy-makers are deeply dependent on expertise to inform decisions [50], c.f. Reference [51]. However, there is a risk that experts will dominate at the expense of citizen influence and democratic values [52,53]. New life forms are not only an extremely technically complex field in need of expert advice, but also a field that concerns all humanity. Consequently, real democratic influence is of utmost importance [54–56].

Other questions concern if moral standing, but also property, agency, and accountability, are exclusively for the human species or extendable to other forms of life as well, such as extraterrestrial life, synthetic life, or autonomous robots [3,57–62].

There will also be questions about how to fit the new life into a religious context. Religious attitudes towards life are dependent on what conceptions of life religious believers have [63–71]. It is therefore not obvious how different religions will relate to life that does not yet exist. From a religious perspective it is sometimes also assumed that the invention of new forms of life is wrong since it means that we are taking over the role of creator. We are “playing God”, so to speak [72–75]. There is also room for discussion among believers of different religions regarding how to relate to life that is created by us and therefore cannot be conceived of as being created by a god.

Accusations of “playing God” or following in the footsteps of Frankenstein are quite regularly aired in connection with synthetic biology and artificial intelligence from secular sources as well [73,76–80] (see also Reference [81]). The basic worry behind this accusation seems to be that even though we might soon acquire enough knowledge to create life, we might not have the wisdom to take responsibility for our creations—both in the sense that we are not prepared for how their arrival will affect us and other existing life forms on the earth today, and in the sense that we do not yet have an ethic that covers their moral status.

A change in how we look at life resulting from a second origin of life can also imply a change in how we value life in general. Some have expressed worries that the ability to manufacture life at will, or the knowledge that our life is not the only life in the universe, will degrade the value of life [42,76,78,80].

One of the most serious potential problems with new life, whether invented or discovered, is that it will become invasive or in other ways threaten existing biological life and ecosystems [37,77,82–84]. An immediate concern is the question of planetary protection [56,85–95]. An example of this is the issue of quarantine for spacecraft to and from Mars [88,96–98]. The European Space Agency (ESA) ExoMars missions be looking for life on Mars but—due to ethical and biological sterilization considerations—will avoid landing in areas judged the most promising for life, first awaiting their detailed study from a distance [99,100]. Sample return missions, now in preparation, will have to evaluate the level of

quarantine required for Martian soil samples brought to Earth. This means that we need to take action in relation to possible extraterrestrial life long before we have found evidence of any such life.

These are all very practical questions concerning all aspects of society, but they also have one thing in common; namely, that how to handle them depends to a large part on how we conceive of and understand both the new life forms, and existing life in view of the arrival of new life forms. The first step in dealing with the practical questions must therefore be to tackle the conceptual question, and to do so in a way that encompasses a wide spectrum of perspectives.

4. Main Aims

The main aims of the project were:

(1) To initiate an inter-disciplinary research initiative at Lund University whose focus will be to investigate how the emergence (finding or inventing) of life with a different origin than life as we know it will influence how we look at life.

(2) To initiate research aimed at handling the challenges identified in (1) in a constructive way.

(3) To create new connections between researchers working in this area at Lund University and between these researchers and researchers at other universities, as well as with society in general in order to improve both research, development, and policy making regarding these new kinds of life.

5. The Performance of the Project

The group of researchers funded by the project represented 12 different disciplines (Table 1).

Table 1. Members of the project team paid by the project.

Name (Affiliation)	Discipline	Role in the Project
Jessica Abbott (Lund University)	Biology	Researcher/project coordinator
Christian Balkenius (Lund University)	Cognitive science	Researcher
Anna Cabak Redei (Lund University)	Semiotics	Researcher/project coordinator
Klara Anna Capova (Durham University)	Anthropology	Guest Researcher
Dainis Dravins (Lund University)	Astronomy	Researcher
David Dunér (Lund University)	History of science and ideas	Researcher
Markus Gunneflo (Lund University)	Law	Researcher
Maria Hedlund (Lund University)	Political science	Researcher
Mats Johansson (Lund University)	Medical ethics	Researcher
Anders Melin (Lund University)	Ethics/theology	Researcher
Erik Persson (Lund University)	Philosophy	Researcher/project leader
Petter Persson (Lund University)	Chemistry	Researcher

The group spent one day per week on location at the PIAS working together, sharing and analyzing each other's perspectives on life, with a focus on expected inventions and discoveries of new kinds of life unrelated to us. The project organized regular visits from researchers from outside the group, with an interest in various perspectives on Life. These visiting researchers interacted with the group and gave seminars (either internal or open to a wider audience). The visiting researchers also became the core of a wider network that is still in operation.

By focusing on the latest developments in areas such as synthetic biology, artificial intelligence, astrobiology, medicine, and robotics, as well as foreseeable future developments in these areas, we were able to formulate new questions and hypotheses that will be the basis of future projects.

In addition to joint weekly working sessions at the Pufendorf Institute, the group participated in study visits to the extremophile studies group at the Äspö Hard Rock Laboratory (<http://www.skb.com/research-and-technology/laboratories/the-aspö-hard-rock-laboratory/>), the Mars Simulation Laboratory at Århus University (<http://projects.au.dk/marslab/>), the robot laboratory at Lund University

Cognitive Studies (<https://www.lucs.lu.se/lucs-robotics-group/>), and the tardigrade research project at Kristianstad University (<https://www.hkr.se/en/research/staff/k.-ingemar-jonsson/research/>). We also presented the project at relevant conferences.

6. Outcomes

- Initiation of a network bringing together researchers working on the discovery or invention of new life, and researchers working with the possible effects of a second origin of life. The project group and its associated researchers make up the starting point of this network. The network communicates mainly through a very active Facebook group.
- Popular science presentations for high school students in cooperation with Folkuniversitetet / Forskningsnätet Skåne. The anthology is distributed to the high school students.
- The identification of specific research questions leading to new grant applications. So far, one such application has been funded (“How will different forward-looking distributions of responsibility affect the long-term development of artificial intelligence?” funded by Marianne and Marcus Wallenberg Foundation, grant number 2018.0020).
- Anthology published in the Pufendorf Book Series [101]. The book was written in Swedish to reach a wider audience. The aim of the anthology was to inspire and initiate further discussion about the topics of the project among experts as well as laypersons.

The book contains the following chapters (chapter titles translated to English):

1. *The fascination for life* (Mats Johansson): This chapter discusses what our fascination about life as a phenomenon has to say about ourselves [102].
2. *What is life? The hunt for a new definition of life* (Jessica Abbott, Erik Persson): This chapter describes the problems with the standard way of defining life as a list of necessary properties, and our work with producing a new definition inspired by Ludwig Wittgenstein’s family resemblance definition [103].
3. *Molecular awakenings* (Petter Persson): This chapter describes the molecular basis for life and the epistemological challenges we face when trying to understand the origin of life, as well as when trying to determine what it takes for a world to be habitable and when trying to construct life from scratch [104].
4. *Life far out in space* (Dainis Dravins): This chapter starts with a short overview of the history of astrobiology and ends with a description of methods and challenges in modern astrobiology [105].
5. *Signs of life: The search for life on foreign worlds* (David Dunér): This chapter discusses biosignatures, what have counted as biosignatures historically, what count as biosignatures today, as well as challenges in determining what should count as a biosignature [106].
6. *Presenting humanity to extraterrestrials* (Anna Klara Capova): This chapter discusses our attempts to send messages to extraterrestrials and what these attempts tell us about how we look at ourselves [107].
7. *Almost alive: Robots and androids* (Christian Balkenius): This chapter discusses attempts to make machines more humanlike. It brings up, among other things, the Turing test and the “uncanny valley” phenomenon [108].
8. *Artificial intelligence as a life form: The legal status of autonomous weapons systems* (Markus Gunneflo): This chapter discusses issues in international law regarding autonomous weapons systems [109].
9. *Artificial intelligence: Who’s responsibility?* (Maria Hedlund): This chapter discusses political challenges in connection with the development of AI. It brings up, among other things, the problem that it is difficult to make truly democratic decisions about this technology because of the heavy dependence on experts [110].
10. *Is synthetic biology morally impermissible?* (Anders Melin): This chapter questions the claim that humans should not take on the role as creator of new life. The discussion is based on the question of who, if anyone, is hurt by such an endeavor [111].

11. *The conception of the human as creator of (in)human life: The example of Mary Shelly's "Frankenstein or the new Prometheus"* (Anna Cabak Redei): This chapter discusses how the human creator is depicted in Shelley's novel about Frankenstein and how this novel is used as a metaphor in discussions about synthetic biology [112].
 12. *Created life and the value of life* (Erik Persson): This chapter questions the claim that if humans acquire the ability to create life, it will negatively affect the value of both the new and existing life [113].
- Five other publications:
 - One report on the status of astrobiology in Europe and its relation to European society [3].
 - One journal article on the attitudes towards the scientific search for extraterrestrial life among high school and university students in Sweden [114].
 - One journal article and one book chapter on biosignatures [115,116].
 - One journal article on the relation between humans and robots [117].
 - Six oral and seven poster presentations at international conferences.
 - Concluding symposium where the associated researchers as well as other national and international researchers in the area were able to meet and exchange ideas (Table 2).

Table 2. Invited speakers at the concluding symposium.

Name	Affiliation
Sherryl Vint	University of California, Riverside, USA
Fredrik Heintz	Linköping University, Sweden
Kelly Smith	Clemson University, USA
Jacques Arnould	Centre National d'Études Spatiales (CNES), France

In conclusion, we found that our approach in relation to the aims of the project was very fruitful and productive. We found, in particular, that our initial assumption that the questions dealt with in this project need an interdisciplinary approach.

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