Astrobiology and Astrophilosophy: Subsuming or bifurcating disciplines?

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Abstract Initially, astrobiology subsumed into philosophy. However, philosophy has increasingly subsumed into astrobiology concurrent with it steadily becoming an observational and experimental activity that mainly focuses on the link between life and the cosmos, rather than on extra-terrestrial life per se. However, the steadily increasing probability of locating such extra-terrestrial life and the questions this will lead to might require a refinement of astrobiology, with a bifurcation into astrobiology and astrophilosophy. There are many reasons for the emergence and necessity of astrobiology. One barely realized reason for its emergence, I will argue, is the dawning realization that biology, until now, has been under a geocentric limitation, which has unavoidably pervaded the perception of life. Additionally, as astrobiology can be said to be a long last movement away from this limitation, astrophilosophy represents a movement away from that limitation because philosophy has, strictly speaking, been restrained by the frames for one species, Homo sapiens. Thus, philosophy has, strictly speaking, been anthropomorphic. Thus, when philosophy, like astrobiology, incorporates the Copernican principle, assuming that terrestrial life, and the thinking of Homo sapiens, is not privileged in the universe, astrophilosophy emerges. Astrobiology and astrophilosophy are not competitors but are rather two distinct but complementary activities that address questions with their own well-defined methods and rigor while still informing each other in an inter-dependent manner. Astrophilosophy concerns questions that are philosophical in nature but are procured by an astrobiological perspective. By including scenarios procured by astrobiology, a number of questions regarding value, rights, communication and intelligence that could arise in the interaction between Homo sapiens and extra-terrestrial life can be addressed.

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1. Introduction

As far back in time as *Homo sapiens* and their predecessors have possessed curiosity and fascination, there have been those among them that have stared up at the starry firmament and wondered: What do we see? Where did it come from? How are we, life itself, connected to all this? What is the meaning of it all?

As the eons went by, they increasingly became better at observing, investigating and measuring what they were seeing, to provide explanations. As the eons went by, they also became better at formulating themselves, asking precise questions, and carefully deriving arguments from arguments to answer these questions. Thus began the steps towards science and thus began the steps towards philosophy. Consequently, the first true questions regarding the connection between life and the cosmos began to emerge.

Since the first definitive discovery of an exoplanet orbiting a main-sequence star, approximately 50 light-years away from the sun, was achieved in 1995 [Mayor and Queloz, 1995], an exoplanet later designated *Dimidium* [International Astronomical Union, 2015], the number of known exoplanets has expanded dramatically. The number of exoplanets orbiting in the habitable zone has also increased dramatically, with perhaps as many as approximately 40 billion Earth-sized exoplanets in this galaxy alone [Petiguraa et al., 2013].

Whether life is an improbable or a probable event that will arise on planets with fitting conditions is a debated question. The fact remains that life appeared relatively quickly after Earth was formed [Dodd et al., 2017], which, although this being a plausibility argument, an extrapolation from a single example, lends some support to the notion that life is a probable event: as soon as conditions permit, it arises. Thus, life might be a common phenomenon in the universe.[1] Thus, with the increasing number of known exoplanets, with the on-going SETI search, with space science in general, the chance of finding extra-terrestrial life increases.

Astrobiology, the interdisciplinary science that combine insights from evolutionary biology, biochemistry, biophysics, planetary science, astronomy, etc., has for a number of reasons emerged to best address this possibility of life.

[1] It is also possible that life is not rigidly confined to a planet. Genetic material might emerge on and be transported by comets to planets [Hoyle and Wickramasinghe, 1986] or be transported by asteroids or meteorites to and from different planets or solar systems [Belbruno et al., 2012]; the so-called panspermia hypothesis. If so, this will probably make life a common phenomenon in the universe.

Despite the fact that extra-terrestrial life has not yet been located, astrobiology is today a sound and well-defined science since it mainly focuses on the link between life and the cosmos, more than on extra-terrestrial life *per se*. One of its research areas is the study of organisms in extreme environments. Here, it is not only these organisms' capabilities to live in extreme terrestrial environments that are being studied; rather, whether these organisms would hypothetically be able to live in similar environments on other planets and moons such as Mars, Europa or Enceladus is also being studied [Billi, 2018]. Thus, in this manner, increased knowledge pertaining to the possibilities and limits of life in the cosmos and thus what type of exoplanets should be focused on in the search for life elsewhere in the galaxy is obtained.[2]

However, just as the discovery of exoplanets was due to a refinement of existing techniques, and astrobiology is a combination and refinement of already existing knowledge, the increased chance for the discovery of extra-terrestrial life, and the questions this discovery will create, might make a refinement of astrobiology be necessary, where the discipline must bifurcate into astrobiology and astrophilosophy.

Discussions made possible by space science and astrobiology, but which have been astrophilosophical in nature, have existed as long as there have been discussions about extra-terrestrial life. Thus, the following exchange of opinions took place during a NASA symposium held in 1972 that explored the implications of the possible existence of extra-terrestrial civilizations [Berendzen, 1973]:

George Wald: 'One of the greatest human enterprises is our understanding. It is something that men have sweated out, to the greater dignity and worth of man. The thought that we might attach, as by an umbilical cord, to some more advanced civilization, with its more advanced science and technology, in outer space does not thrill me, but just the opposite.'

Carl Sagan: 'I try to imagine back to when I was working hard as a student. There were a lot of textbooks. I would open up those textbooks and in there would be what other guys had found out. Now I did not approach each phase saying, 'Oh, my God! They know that also!''

Both men state important considerations that are far from being trivial. Will contact with a friendly extra-terrestrial civilization, ahead of *Homo sapiens* in science and philosophy by thousands of years, have a demoralizing effect on their imperative to explore and learn? This is an important issue to address.

Initially, as a relatively new science, astrobiology was subsumed into philosophy since the main questions could only be reflected upon. However, philosophy has been increasingly subsumed into astrobiology concurrently with astrobiology, steadily becoming an observational and experimental science. However, should there instead be a sharper distinction between them? Science and philosophy are well-defined disciplines; should there thus be a distinction between astrobiology and an independent discipline called astrophilosophy?

Will research on both sides be more fruitful if it is performed after this division? For instance, physics and philosophy was once one and the same enterprise. However, they have since gained sharper boundaries, and both disciplines enjoy great success as a consequence. Nevertheless, they maintain a fruitful interaction with each other, and they have this successful interaction precisely because they are distinctive disciplines' with their own well-founded methodologies.

It might be objected that there has essentially already long been a discipline of theoretical astrobiology and that the discipline simply is divided between theoretical and experimental astrobiology, in the same manner as physics, for instance. However, that would not be correct. Theoretical and experimental physics still occur within a scientific framework. However, science and philosophy are distinctive disciplines addressing questions in different manners.

If there is life elsewhere in the cosmos, then astrobiology will explore it. However, that life, and *Homo sapiens'* interaction with it, will initiate a long line of questions pertaining to value, rights, communication and intelligence, which are better addressed by astrophilosophy.

2. Geocentric and anthropomorphic attitudes contra the Copernican principle

There exist many reasons for the emergence and necessity of astrobiology, a discipline that can be defined as 'the study of the origin, evolution, distribution, and future of life in the universe' [NASA Astrobiology Institute, 2008]. The term itself emerged in 1953 [Tikhov, 1953] to address the dawning realization that among the vast number of galaxies, stars, planets and moons are genuine possibilities for more life than just on Earth, although the discipline today mainly focus

[2] It is important to remark here that an extremophile's capability to live in a given planet's extreme environment is not the same as that life form being able to emerge on that planet. The predecessors to extremophiles, the first life that emerged, were probably fragile life that required a more relaxed environment.

on organic molecules in space, abiogenesis on Earth, the potential for terrestrial life to adapt to environments on exoplanets, etc.

One further and barely realized reason for its emergence, I will argue, is the dawning realization that biology until then had been geocentric. Biology has, understandably, only been able to concern itself with life on this planet, which has unavoidably shaped the perception of life. Astrobiology can thus be said to be a long last movement away from this limitation.

Throughout time, this geocentric limitation has also shaped an anthropomorphic attitude towards the universe. This attitude is especially well illustrated in astronomy, where the Copernican principle, stating that Earth is not privileged in the universe [Bondi, 1952], has led to a retreat of this anthropomorphic attitude. Thus, the Earth is not the centre of the universe, the sun is not the centre of the universe, the galaxy is not the centre of the universe, and even the universe itself may be only one among countless others in a vast multiverse.

This geocentric limitation has also been known in biology, where the study of life throughout time has been pervaded by an anthropomorphic attitude. However, the development in biology has, as for astronomy, observed a retreat of that attitude. Thus, *Homo sapiens* were not the centre of nature; they were not the end goal of evolution; they were not separate from nature. This transition is essentially the Copernican principle in effect. *Homo sapiens* are not the dominant species on this planet (unicellular organisms are), other species do not exist for the sake of *Homo sapiens*, and *Homo sapiens* do not possess unique traits. In other words, *Homo sapiens* are not privileged in the biological universe.

Philosophy has also fundamentally been pervaded by the same issue as biology. Philosophy has been restrained by being geocentric and pervaded only by the frames of one planet and one species, *Homo sapiens*, much like how science previously suffered from a lack of knowledge about how vast this universe is.

Astrobiology has many tasks; one of these is to determine whether the characteristics that life on this planet possesses are truly universal or merely the result of circumstances historically specific to Earth [von Hegner, 2019]. Thus, like how the localization of life elsewhere in the universe might revise the attitude of what life is, if the search for what is essentially terrestrial life on extra-terrestrial planets shows that this life is different, then the finding of life with complex intelligence elsewhere in the universe might also revise philosophy.

Thus, just as the science of life, biology, understandably enough has been performed from a terrestrial perspective, due to only one example of life being available, Earth-based life, then also philosophy has been performed only from an Earth-based perspective. Of course, philosophy is not a static discipline. Philosophy revises and develops itself. However, that is not the point here. The point is that the difference between a geocentric and a universal philosophy can turn out to profound.

This might be objected to with the claim that philosophy already is a universal discipline. Philosophy has many divisions into disciplines such as the philosophy of ethics, philosophy of language, etc., but it still follows that philosophy overall is universal.

However, is it really? How can this be claimed? There is only one example of philosophy, one data point. Philosophy is undeniably an activity performed by *Homo sapiens*, between *Homo sapiens*. Philosophy is restricted by their interactions, ideas, languages, cultures and lives. Thus, philosophy is, strictly speaking, anthropomorphic.

This observation may appear trivial. *Homo sapiens* are the only species on this planet with the mental faculties to engage in philosophy, and thus this situation should not be surprising. However, that is exactly the point, 'on this planet'. Astrobiology depends on the assumption, among others, that there can be life elsewhere in the universe. Among that life, there might be life that has developed the mental faculties to do philosophy. Thus, on some exoplanets, there may also be exophilosophy.

That this anthropomorphic attitude exists and is an issue can be illustrated by the division that has long existed in philosophy. Thus, the dominating assumption has long been that it is *Homo sapiens* that create the reality of the universe, rather than the universe enforcing its reality on *Homo sapiens*.

A prime example of this is the influential ideology social constructivism, which claims that 'reality is constructed through human activity. Members of a society together invent the properties of the world … reality cannot be discovered: it does not exist prior to its social invention … knowledge is also a human product, and is socially and culturally constructed'[3] [Kim, 2001].

[3] Such ideologies are of course easily counteracted. If reality itself is constructed through human activity, and the properties of the world are a human product that are culturally constructed in certain time periods and locations, and thus cannot any more than any other social invention be objectively valid, then it *ipso facto* follows that this ideology, social constructivism, according to itself is also socially and culturally constructed in certain time periods and locations. Social constructivism is a human product. It follows that social constructivism cannot be objectively valid because its claims precisely hold for all epistemology and thus *ipso facto* also for itself. This ideology is thus a self-refuting view that cannot be true because it logically conflicts with the conditions for its own validity. This argument cannot be countered by claiming social constructivism must apply for all ideologies except itself. To do so, it once again self-refutes itself by claiming that at least one truth, one reality, exists independently of *Homo sapiens*.

A more mature assumption is observed in e.g., Kant's philosophy [Kant, 1999]. Here, the universe does indeed exist independently of *Homo sapiens*, but *Homo sapiens* nevertheless structure the universe from a priori forms and categories – the universe is conceptualisation dependent, that is, dependent of *Homo sapiens*. The conceptualization of the universe is conditioned by the a priori forms and categories of *Homo sapiens*, and thus there cannot be referred to something that is non-conceptualized. The universe in itself is thus something amorphous, meaning that e.g., stars and planets did not exist before being conceptualized.[4]

There are many other examples, which, however, are unnecessary to mention here. If one or several other species that was in possession of complex intelligence on the same level as *Homo sapiens* existed here on Earth, say, *Pan paniscus* or *Tursiops truncatus*, and thus so did science and philosophy, would *Homo sapiens* then in all likelihood not have gotten rid of such attitudes long ago? Would such attitudes have arisen at all? How would *Homo sapiens* view an extra-terrestrial species with complex intelligence similar to their own, who through their transmitted message informed *Homo sapiens* about their belief that the whole universe, including *Homo sapiens*, existed or was structured because this species created or structured it?

Most scientists work implicit, mostly without attempting to formulate the assumption directly, with the opposite assumption, following the Copernican principle, i.e., assuming that the thinking of *Homo sapiens* is not privileged. It is not *Homo sapiens* who create the reality of the universe; rather, it is the universe that enforces its reality on all life.

Of course, there is also only one example of science, which is also made by *Homo sapiens*, between *Homo sapiens*. However, much science has the advantage that it can test itself through observations. The biology of *Homo sapiens* can be tested against the biology of other life forms on this planet; the biology of *Homo sapiens* does not stand alone but rather is in an open system that interacts with all other life. However, philosophy does not interact with other life forms; it is strictly an enterprise for *Homo sapiens*. A discipline such as astrophysics can test itself via observations of phenomena beyond this planet. For instance, fusion reactions on Earth are the same as those that take place in the stars [Burbidge et al., 1957]. However, this is an advantage that philosophy does not have since no other civilization in the universe that has what could be called philosophy is known yet. Thus, philosophy has to an even higher degree than biology been pervaded by an anthropomorphic attitude.

The above is not a criticism of the value or existence justification of philosophy *per se*, any more than it is a criticism of the value or existence justification of biology *per se*; it is merely the clarification of a limitation. However, as the emergence of astrobiology is a necessary development away from the geocentric limitation of biology, a development that moves philosophy away from the geocentric limitation and anthropomorphic attitude is necessary. Thus, when philosophy incorporates the Copernican principle, astrophilosophy emerges.

3. Astrobiology and astrophilosophy: unification or bifurcation?

One reason there shall be a distinction between astrobiology and astrophilosophy is that these disciplines addresses questions with their own methodology, their own rigor, even if it is the same subject they addresses. For example, life is a subject for biology and a common one for philosophy. However, questions such as whether life has value are, interestingly enough, only questions for philosophy. If the galaxy is actually teeming with life, if life arise on virtually any planet or moon with the right conditions, then the question of whether such entire planets or moons with life have value is not a question for astrobiology but rather one for astrophilosophy.

Science and philosophy are thus two distinct but complementary activities. They are not competitors but rather operate via different methodologies.

Astrobiology, like all natural sciences, is a self-corrective interaction among observation, hypothesis, experiment and theory pertaining to the exploration of all natural phenomena.

Astrophilosophy, like virtually all philosophy, is comprised of methods of dialectic analysis and logical argumentation, pertaining to the clarification of the nature of reality.

Thus, astrophilosophy as a discipline is not measured by its potential to solve astrobiology problems because astrobiology is already there to solve astrobiology problems. Likewise, astrobiology as a discipline is not dictated by astrophilosophy because astrobiology is already dictated by those who do astrobiology. Both disciplines are thus better suited to address questions with their own methodologies. Nevertheless, they do need and inform each other in an inter-dependent manner because these methodologies can also occasionally require input from the other discipline to learn where a mistake has occurred.

[4] Is it possible for a given species to talk about the universe independently of their conceptualization? Presumably not. However, from this, it does not follow that the conceptualization of the universe is conditioned by the a priori forms and categories of a given species. Instead, the a priori forms and categories of a given species are evolutionarily conditioned by the way in which the universe is structured. This clarification is not biological reductionism; rather, it simply expresses that the universe is structured in a certain way, meaning that one only can act and communicate unambiguously in certain ways.

4. Examples

Astrophilosophy does not attempt to replace astrobiology regarding the question of whether there is extra-terrestrial life in the universe. That question is a matter of evidence, and arguments about this subject alone cannot replace a scientific program on this matter. However, then what can astrophilosophy mean? Is it about extra-terrestrial civilizations' philosophy? Is it about the philosophy of life at a cosmic scale? Is it about why life exists? This would be naive to assume.

Instead, astrophilosophy concerns itself with questions that are philosophical in nature but is procured by an astrobiological perspective.

As previously mentioned, the difference between a geocentric and a universal philosophy can turn out to be profound. However, since no contact with a hypothetical extra-terrestrial civilization has yet been achieved, it is obviously not an easy task to conjecture about that difference since we, as *Homo sapiens ipso facto*, ourselves are subjected to that geocentric limitation and, so to speak, are 'stuck' in that very anthropomorphic attitude. However, by including scenarios made possible by astrobiology, even in the absence of knowledge of such a difference, questions that might arise in the interaction between *Homo sapiens* and hypothetical extra-terrestrial life can be addressed in a stepwise manner. The following scenarios attempt this and are by no means an exhausting list.

4.1. An inhabited exoplanet

Imagine that an exoplanet suitable for terrestrial life is located. Imagine that it is the case that life exists on it. Do *Homo sapiens* then have a right to attempt to colonize that world, or does it belong to that life? This type of discussion has been debated ever since the idea of reciprocal space contamination was first suggested [Lederberg and Cowie, 1958]. What can astrobiology say about this topic? It will be able to inquire into the following, for example:

(i) Does the life on the exoplanet consist solely of unicellular organisms, as may be the case on many exoplanets with life?
(ii) Does the life on the exoplanet also consist of multicellular organisms, of which some possess intelligence?
(iii) Does the life on the exoplanet also consist of species, of which one or more possesses complex intelligence?

Astrobiology will not be able to inquire into the following:

(iv) If there only exist unicellular organisms on the exoplanet, then *Homo sapiens* have a right to colonize it.
(v) If there also exist multicellular organisms on the exoplanet, of which some possesses intelligence, then maybe *Homo sapiens* have no right to colonize it.
(vi) If there also exist life with complex intelligence on the exoplanet, then the planet is theirs, and *Homo sapiens* have no right to attempt to colonize that world.

Astrophilosophy will, informed by astrobiology, note that the first 3 points are topics of scientific investigation, whereas the 3 remaining points are reminiscent of the ranking of life that portrays evolution as a type of ladder of progress, leading from unicellular organisms towards multicellular intelligent organisms, the underlying assumption being that evolution is evolving organisms to become similar to *Homo sapiens*.

Astrobiology does not work with this ranking of life because it is an anthropomorphic attitude. The well-known illustration *The March of Progress* that shows the evolution of humankind as a linear progressive sequence does not represent evolution correctly [Gould, 1996]. Thus, modern taxonomic classification is based on an evolutionary relationship between all organisms, where so-called higher and lower life forms possesses no meaning.

Thus, from a strict biological point of view, it cannot be stated that some species have greater importance than others. It cannot even be stated that *Homo sapiens* are more evolved. Species arise through adaptation to a certain environment, via competition through survival and reproduction, not because species proceed towards a higher goal [Gould, 1996]. Therefore, the question of whether *Homo sapiens* have a right to colonize this other world cannot be answered solely on the basis of what type of life there is on it.

An objection against the above might be that certain multicellular organisms (more precisely, *Homo sapiens*) have an inherent value in themselves, a right to its life, to a degree that unicellular organisms do not have.

However, astrophilosophy will, informed by astrobiology, note that all life on this planet shares a common origin, and despite this relationship, many species sustain life by consuming each other, and they all compete, even members within the same species, with each other for survival and reproduction. In other words, life itself does not respect such an inherent value. Nature does not distinguish between life forms' importance or non-importance. If *Homo sapiens* vanished, it would be mourned no more than when *Australopithecus boisei* vanished.

If the claim that a specific species has special rights is still made, then this is from a philosophical side designated speciesism, a prejudice based on group membership and ethical irrelevant physical characteristics. It is an unjustified treatment of one species as ethically more important than another species even when the interests of these species are the same [Ryder, 2010]. Importantly, these points, of course, also hold for the life on the exoplanet in question. That life cannot be said to hold inherent value or rights.

There is, of course, one thing that distinguishes *Homo sapiens* from the rest of the terrestrial life: complex intelligence.

However, why is that an important factor? There are perhaps more than 30 million species currently on Earth, and it can be hypothesized that there have been more than 50 billion species since life emerged [Mayr, 1995]. Most of this life has not been in possession of what could be designated higher intelligence. In fact, life has in most of its history survived without faculty at all. Thus, it is not apparent how higher intelligence gives rights compared to species with no intelligence. That the possession of complex intelligence gives rights, even when there is only one species on this planet in possession of it, is unavoidably a self-referring and anthropomorphic claim.

Thus, whether life possesses different value, whether terrestrial life has a right to colonize suitable exoplanets, is interestingly enough not an astrobiological question. Sound and valid arguments for why terrestrial life should colonize suitable exoplanets already harbouring life may very well exist, it is important to emphasize. However, this question is better addressed by astrophilosophy.

4.2. Uninhabited exoplanets

Imagine that it is the case that no life exists elsewhere in the immediate galactic neighbourhood. Should *Homo sapiens* then attempt to plant fitting terrestrial life, extremophiles or genetically engineered life, on suitable exoplanets? Should the rare life be turned into a general life, even if *Homo sapiens* have no plans of settling there themselves or are not able to do so without continuously living in space habitats? What can astrobiology say about this topic? It will be able to inquire into the following, for example:

(i) If an exoplanet is suitable for life, then it is suitable for life.
(ii) From being a localized singular event 4 billion years ago, terrestrial life has now colonized and adapted to most habitats on Earth. Life expands.
(iii) There have been 5 major mass extinction events on Earth that either greatly affected the course of life or came close to eliminate it [Raup and Sepkoski, 1982].

Astrobiology will not be able to enquire into the following:

(iv) If an exoplanet is suitable for life, then *Homo sapiens* should colonize it with life.
(v) Life is rarer or more precious than known previously (according to the scenario); therefore, *Homo sapiens* should fill the galaxy with life.
(vi) A sixth major mass extinction event is probable; thus, *Homo sapiens* should spread life to other worlds.

Astrophilosophy will, informed by astrobiology, note that the 3 first points are valid arguments based on facts because they concern whether something is. However, it will note that the 3 remaining argument are not. That something ‘is’ and something ‘should’ can traditionally not be derived from each other [Black, 1964]. That life is spreading and life should be spreading are two different arguments. That is one primary reason for why science traditionally does not occupy itself with, for example, ethics, whereas philosophy does.

Nevertheless, should life not be spreading, is it not good in itself that it does? All terrestrial species dedicate resources into reproduction and offspring, including that most *Homo sapiens* feel an instinctive need to continue their genetic heritance. It seems to be a further development of this instinct that *Homo sapiens* will continue the genetic heritance from Earth further out in the galaxy.

However, this is a genetic imprint from evolution, it is not evolution itself. Evolution does not make plans, it does not have goals. Living long enough to reproduce is the mechanism on which evolution is based. Natural selection is a non-random process [Varki, 2012], but it is still only a process. Natural selection is not a choice or a wish. Claiming otherwise is anthropomorphizing nature.

However, should life not be spreading in the galaxy because life has an inherent value? However, it is not easy to demonstrate such an inherent value. Life itself does not respect any inherent value. In fact, nature does not ‘care’ whether individuals, populations, species or even entire ecosystems live or not. Most species that have existed on this planet have vanished again without regard to any inherent value. Just the application of the word ‘care’ is anthropomorphizing nature.

Therefore, it could be claimed that the only thing that seems to bestow inherent value on life is life itself. *Homo sapiens* existentially decide that life is important and choose to continue it in the galaxy. That is sufficient, is it not?

However, here the argument could be made more complicated. It could turn out that *Homo sapiens* indeed share the galaxy with just one single inhabited world far from their immediate neighbourhood and share it with another advanced civilization. This extra-terrestrial species, however, does not think that life has an inherent value, and they are adamant at telling *Homo sapiens* that life should stay on the planet on which it arose. This point is important because here, the self-referring and anthropomorphic attitude is confronted by an exophilosophy. Here, there are two different worlds, each with its own terrestrial attitude.

Thus, whether life has inherent value, whether life should be spread to suitable exoplanets, is, interestingly enough, not an astrobiological question. There are countless things that can and do prevent life from spreading. Thus, it is not a natural given fact that life must spread. Sound and valid arguments that life should be deliberately spread to suitable exoplanets may very well exist, it is important to emphasize. However, this question is better addressed by astrophilosophy.

4.3. Extra-terrestrial speciesism

Imagine a close encounter of the fifth kind. Earth is visited by an advanced extra-terrestrial civilization. The Copernican principle assuming that terrestrial life is not privileged in the universe is verified. Consider next the well-known fact, that many *Homo sapiens* consume or exploit other animals. Whether they ethically have a right to do so is already the topic of an extensive debate but still in many ways a terrestrially informed ethical debate. The following two arguments will be focused on here:

(i) *Homo sapiens* are justified in consuming members of other species due to the fact they are more intelligent and possess a richer emotional register than other species.

Thus, the biological fact that all species on this planet share a common origin and that *Homo sapiens*, compared with e.g. *Sus scrofa*, do not possess any unique trait is freely admitted; there are only differences in degree. *Sus scrofa* clearly possess intelligence and an emotional register. However, *Homo sapiens* has a greater degree of these and thus are justified in consuming other species and to live at their expense.

(ii) *Homo sapiens* are not consumed by other species due to the fact that they have the power to prevent other species from consuming them.

Thus, an empirical fact is freely admitted. This power is furthermore the reason that *Homo sapiens* can consume other species, despite other species not wanting to be consumed by them. In this manner, *Homo sapiens* are superior to their fellow animals, leading to the exclusion of all other animals from the rights and considerations afforded to *Homo sapiens.*

Astrophilosophy will note that evolutionary biology is an integral part of the astrobiological framework and the facts mentioned in the above are stated by it. However, there are a number of assumptions in the arguments that cannot be addressed by astrobiology. These arguments are empirically valid in the sense that many species live off each other and *Homo sapiens* are simply in control. This is not an ethical argument *per se*, but so what?

However, these may be dangerous arguments because, once again, the geocentric limitation and the anthropomorphic attitude, which have affected biology and philosophy for so long, are at play. These limitations are clearly observed if one proceeds from terrestrial speciesism to extra-terrestrial speciesism. Imagine, as previously stated, that an advanced extra-terrestrial civilization arrives on Earth. However, this extra-terrestrial civilization does not come as friendly visitors but rather comes in the style of the worst science fiction movie to bring Earth, or more precisely, *Homo sapiens*, to their larder due to, say, the qualia of *Homo sapiens*. They are as advanced in terms of intelligence and emotion compared to *Homo sapiens* as *Homo sapiens* are compared to *Sus scrofa.*

However, this implies that following argument (i), *Homo sapiens* cannot provide an ethical argument for why this extra-terrestrial civilization should not have a right to do so.

Homo sapiens could highlight to them that what they plan to do is based on speciesism, a prejudice based on group membership and ethically irrelevant physical characteristics [Gruen, 2017], that they are prejudicial because there is no *prima facie* justification for allowing the interests of their species to override the interests of *Homo sapiens.* However, how can they say that?

In argument (i), *Homo sapiens* defend their own treatment of one species as ethically more important than another species even if the interests of these two species are the same. They can justify this by pointing out a difference in degree. Both *Homo sapiens* and *Sus scrofa* want to be able to consume and drink, be safe and reproduce. However, *Sus scrofa* do not possess the intelligence allowing it to understand, for example, the utility of building strong houses or

establishing a police force for protection. *Sus scrofa* do not understand or feel the value of, for example, maintaining family ties with their offspring after they grow up.

However, regarding the extra-terrestrial civilization, it can in a similar fashion be the case, for example, that there are natural phenomena that *Homo sapiens* are simply unable to understand (or have not yet been able to understand) but that the extra-terrestrial civilization have understood, e.g., how this universe came to be is child's play for them, or they create art that demands an advanced emotional register that *Homo sapiens* do not possess.

They give the same justification as *Homo sapiens* based on speciesism, a discrimination based on species membership [Ryder, 2010]. For them, *Homo sapiens* are simply not sufficiently intelligent or emotionally sophisticated to be given the same rights as they have or to be considered ethically equals. Thus, the consumption of *Homo sapiens* is therefore ethically justified.

In argument (ii), it is stated that *Homo sapiens* can consume other species due to the fact that they have the power to consume other species. However, the extra-terrestrial civilization is more powerful than *Homo sapiens* and is superior; thus, according to the same type of argument, they do not need to afford *Homo sapiens* the same rights that they themselves possess.

These two points are simply extrapolating the terrestrial facts up to extra-terrestrial versions. Thus, here, an interesting ethical dilemma procured by astrobiology is stated, but it is better addressed by astrophilosophy.

4.4. Supra-quantum intelligence

Imagine an extra-terrestrial complex intelligence somewhere on an exoplanet. Communication and a form of physical interaction between this and an arriving *Homo sapiens* could be expected. However, will this also be possible?

How consciousness is produced is still an intensely debated question. The consensus in neurobiology appears to be that the conscious mental state is an emergent phenomenon arising through the network of neurons [Piccinini and Bahar, 2012]. The brain of a *Homo sapiens* contains more than 10^{11} neurons, cells, that collectively make up a large interconnected network designated the connectome [Sporns et al., 2005]. It is this complex and adaptive network of electrochemical interactions, not single neurons themselves, that together produce consciousness.

It has been proposed that this mental state can also be produced by a network composed of components other than neurons [Koene, 2012]. Thus, for example, the China brain thought experiment hypothesizes what would happen if each citizen in China, consisting of 1 billion *Homo sapiens*, were tasked to simulate the action of a single neuron in the brain, sending signals to each other according to specific protocols to simulate the axons and dendrites that connect neurons [Block, 1978]. Would this collective arrangement that is connected to an external body possess a consciousness functionally equivalent to that of a brain? Some have agreed that the China brain does indeed create a consciousness [Dennett, 1991].

This scenario is quite fascinating in itself. However, an even more fascinating astrobiological scenario can be put forward. Let an exoplanet be imagined, an exoplanet harbouring unicellular organisms, the most widespread life form on Earth. In this scenario, will a large number of these, instead of following the evolutionary path known from Earth, are connected in such a manner that they form a loosely interacting group. In other words, instead of 1.4×10^9 Chinese people, there are 10^{12} unicellular organisms forming a connectome.

This will be a connectome of individual organisms. This network of unicellular organisms that individually have no consciousness possesses an emergent consciousness according to the China brain scenario. However, that is not all. Let it be imagined that a number of the unicellular organisms in this network happens to be in a quantum state.

Quantum effects play a role in biology as they do for everything else, but this is in a trivial sense. However, quantum biology has sought answers for whether macroscopic biological objects can experience quantum effects in a non-trivial sense. Thus, can the quantum world ever be large enough for its most counterintuitive effects to manifest in living objects?

That seems to be the case. Thus, quantum superposition has been demonstrated for complex C_{60} molecules [Arndt et al., 1999]. An experiment has possibly demonstrated quantum coherence in the form of a Fröhlich condensate for proteins [Lundholm et al., 2015]. An experiment has possibly demonstrated quantum entanglement of photosynthetic molecules within a green sulfur bacteria in a non-trivial sense [Marletto et al., 2018].

Thus, an extrapolation may be whether it will be possible to induce an entire living unicellular organism to displaying quantum effects or whether it will be possible to entangle two living unicellular organisms together. It is possible that there exist even smaller life forms than bacteria, as has been suggested with nanobes [Uwins et al., 1998] or nanobacteria [Kajander and Ciftcioglu, 1998]. The smaller an organism is, the greater the chance for quantum effects to arise.

Therefore, a connectome is imagined here that has components, such as nanobacteria-like organisms, in quantum states. Whether such an organism will ever be a reality, or if there is too many physical variables at play for it to happen, is a matter for discussion. However, statistically improbable is not the same as statistically impossible. Thus, let

it be followed as a thought experiment, nothing more, nothing less. Therefore evolution may have made it possible for living systems to naturally utilize such quantum-mechanical adaptations in certain environments.

Such a supra-quantum organism or intelligence would of course be a remarkable creature in itself, being highly interesting for astrobiology. It would perhaps be even more interesting for astrophilosophy. Because next to the question of whether it truly possesses a consciousness, the question of how to communicate with it arises. If it as a matter of simplification is assumed that it has intelligence on the same level as *Homo sapiens*, the issue of how communication with this creature can be established arises.

The interesting aspect is not the practical communication itself but rather the fact that parts of it are in quantum states in a non-trivial sense. Since the quantum world is counter-intuitive compared with many macroscopic phenomena, then this will mean that a nanobacteria-like organism can appear in two places at once – superposition, or that two separated organisms possess mutual information independently of their distance from each other – entanglement, or that two organisms can behave as a single entity – coherence.

This means *ipso facto* that this creature will have a consciousness different from everything known on Earth. Thus, some of its components will experience spatial dimensions differently, will experience temporal dimensions differently, will exploit information differently. It will be able to experience linear thinking differently and may even defy causality [Goswami et al., 2018] since time is also described differently.

Such quantum states may only last for a short while, but the moments they last are principally interesting. Astrophilosophy is very much about language. The language and understanding of *Homo sapiens* is evolutionarily shaped by the way in which the macroscopic world is structured, which is the reason why the quantum world has been so mindboggling to many. This creature follows as expected all the laws of physics, all the possibilities of biology, just as *Homo sapiens* does. Nevertheless, both communication and physical interaction between this and a visiting *Homo sapiens* will still represent considerable obstacles, all perhaps better addressed by astrophilosophy.

4.5. Conditions for description

Imagine that this universe is only one among others in a vast multiverse [Kragh, 2009]. Such other universes might be on the borderline of what could considered the scope of astrobiology; however, the question of communication between extra-terrestrial species is an area of astrophilosophy. In this case, with a multiverse, it will no longer be a geocentric limitation of biology or philosophy but rather a unicentric limitation.

Imagine that it will be possible for *Homo sapiens* to gain contact with a civilization in a different universe; will they then be able to communicate with them? This is not a question similar to the question of whether *Homo sapiens* would be able to communicate with an extra-terrestrial civilization that, like *Homo sapiens*, originates in this universe. In fact, the situation is very different indeed.

Homo sapiens can only act in certain ways as a consequence of the universe being structured in a certain way. But they can likewise also only communicate unambiguously in a certain way to each other as a consequence of the universe being structured in a certain way. There are, in other words, conditions for action, as well as conditions for communication that *Homo sapiens*, being part of the universe, being in the universe so to speak, must follow [Favrholdt, 1999], which is why the laws of nature are valid in all cultures and are the same among all hypothetical species in the universe and why that even though words and concepts are invented, they nevertheless represent a reality independent of *Homo sapiens* in unambiguous communication.

Thus, every living being follows, for instance, divalent logic, which states that ‘a thing cannot both exist and not exist to one and the same time’ or ‘a unambiguous sentence cannot both be true and false to one and the same time’ [Favrholdt, 1994]. This applies to both action and communication. These logical principles do not derive from an agreement.[5] They are a clarification of how this universe is structured.

This is why the multiverse theory is especially interesting. For while *Homo sapiens* will be capable of developing communication with other intelligent species in this universe as a consequence of everyone being enforced to act and communicate in a certain way, the situation may be different for another universe because in such a different universe, there may be a different set of laws of nature due to this universe being structured differently.

In such a universe, divalent logic may not apply. However, it then follows that *Homo sapiens* cannot understand extra-terrestrial life in that universe, just as it follows that they will not be able to understand *Homo sapiens*, either. In fact, assuming it was possible to visit each other’s universe, it would likely appear as incomprehensible magic being there, with the laws of nature being so different.

[5] One can, of course, declare a disagreement in this. However, in order to declare that disagreement, it is necessary to adhere to that very divalent logic, thus *ipso facto* affirming it. One can also point to polyvalent logic. However, since these necessarily must be free of contradictions and one in order to introduce a polyvalent logic, ultimately has to use that very divalent logic, then it is not an alternative; thus, it is *ipso facto* the one adhered to. Divalent logic is thus a condition for description for unambiguous communication.

In this scenario, a profound difference between philosophy and astrophilosophy is especially apparent. Here, it is possible to point to why and where that difference appears, but being stuck in the conditions for description in this universe, it is not presently, or perhaps ever, possible to understand what that difference entails.

4.6. Complex intelligence

One of the defining traits of *Homo sapiens* is the possession of complex intelligence, which has enabled them to accomplish things on this planet that appear remarkable compared with other species. Thus, it would appear to be the case that the questions of whether complex intelligence follows from life and is important for life are questions for astrophilosophy. However, they are actually better addressed by astrobiology because these, interestingly enough, have only been relevant for astrophilosophy because these have so far been geocentric questions.

There has possibly been more than 50 billion species on Earth since the emergence of life [Mayr, 1995], and many data points about terrestrial intelligence *per se* are available. These data show that throughout life's approximately 4 billion years of existence on this planet, most of these species have managed without the possession of advanced intelligence or intelligence at all.[6]

Nevertheless, there are many terrestrial species that possesses intelligence, among them, a number that possess advanced intelligence, such as primates, squids and dolphins just to mention a few. Only one species possesses complex intelligence, however, here defined as the potential to do science and philosophy. However, hominids have only used stone tools during the last 3.3 million years [Harmand et al., 2015], while modern *Homo sapiens* only emerged between 350.000 and 260.000 years ago [Schlebusch et al., 2017].

Thus, based on these data, it appears that complex intelligence does not with any high probability follow from life. It also seems that with high probability, complex intelligence is not important for life, understood as important for reproductive fitness.

These are valid points, but only so in light of geocentric biology. There is only one data point regarding complex intelligence available, one example of it. It is, scientifically speaking, always difficult to extrapolate from a single instance. What can be inferred with only one data point available is restricted, like having only one point in a coordinate system.

Astrophilosophy also works better when more data are available; however, it is nonetheless still better suited to address complex intelligence, it since that one point does exist. Complex intelligence is obviously decisive when first in place. With this, *Homo sapiens* have since the beginning of the Holocene approximately 11,700 years ago achieved things on this planet that seem remarkable compared with other species and gained an insight in the universe beyond the capability of all other species. That one data point would therefore currently be a subject for astrophilosophy, but primarily because there is only this one data point. For example, not much philosophical analysis regarding biological reproduction is performed. That was once the case, but it is now described in such detail by science itself that there is not much relevance for dialectic analysis and logical argumentation regarding that subject any longer.

Astrobiology potentially has the capacity to answer whether complex intelligence follows from life and is important for life. It cannot be said with a high probability that if extra-terrestrial life exists somewhere, then it will also gain complex intelligence in due time because evolution does not proceed on a straight line toward a predicable objective, as happens with, say, chemical processes.

However, an important point is that it also cannot yet be said what the probability for that complex intelligence follows of life in the universe is. On Earth, that probability has turned out to be very modest. However, if knowledge of thousands of different exoplanets harbouring life is gained, and among several of these is complex intelligence, then more data points that narrow down the series of probabilities to answer the question whether complex intelligence follows from life and is important for life will be obtained.

This does not mean of course, that complex intelligence before and after is not a question for astrophilosophy; it certainly is. However, in this case, it means that it is better addressed by astrobiology.

5. Summary

Astrobiology has moved beyond biology by incorporating the Copernican principle, assuming that terrestrial life is not privileged in the universe. Likewise, astrophilosophy will move beyond philosophy by incorporating that same principle, assuming that *Homo sapiens* and the thinking of *Homo sapiens* are not privileged in the universe. Thus, both

[6] Of course, most of Earth's species have vanished again. Therefore, whether there is a correlation between advanced intelligence and the capacity to survive long-term is an interesting question in itself.

disciplines proceed from the geocentric limitation and anthropomorphic attitude that have so long hampered both biology and philosophy.

The examples discussed in this article show that astrobiology and astrophilosophy are closely intertwined with each other, but there are still questions better addressed by each discipline. Much more could and should have been discussed here. However, astrobiology and astrophilosophy are obviously large areas, and hence, only some relevant points have been addressed.

I have not made any serious attempt to provide answers to the points put forward. Personally, I think, for example, that we should seed life on every single inhabited, but suitable, exoplanet and exomoon that we locate within reach; the sooner the better. However, I am acutely aware that my argumentation must be within the right framework.

Much can be said, and answering these points could be objectives for many articles. My goal was to show that it is advantageous to divide the current discipline astrobiology into two independent disciplines. That distinction is both necessary and an advantage. Astrobiology and astrophilosophy are two distinct activities that work using different methodologies. Thus, being, for instance, a talented astronomer does not necessarily lead to being a talented philosopher, or vice versa.

Astrobiology is needed to address life beyond this planet, but this life, and its interaction with *Homo sapiens,* will lead to many questions better addressed by astrophilosophy.

Homo sapiens possess the ability to examine and understand reality. From being geocentric wanderers, they are ready to be wanderers of this vast and wonderful cosmos. Much remains unknown; nothing is unknowable in advance. To learn about our neighbourhood, interact with it, and influence it, we need the right tools, the right knowledge, and the right questioning techniques. We have those with astrobiology, and we have those with astrophilosophy.

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