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Astrobioethics: a brief discussion from the epistemological, religious and societal dimension

Octavio A. Chon-Torres[1]

Programa de Estudios Generales, Universidad de Lima, Lima, Peru

Research Article

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Author for correspondence:
Octavio A. Chon-Torres, E-mail: ochon@ulima.edu.pe

Abstract

As astrobiology progresses in its quest to discover life on other planets or to put ourselves in another one, so does its moral problematic. Astrobiology is not only part of natural sciences, but also deals with direct aspects of humanities. For this reason, this paper aims to briefly examine astrobioethics from the epistemological, religious and societal dimension. It also deals with different researches in this regard, in order to better understand the state of the art on this topic and that astrobioethics can help us not only on how we should relate with extraterrestrial lifeforms, but even with terrestrials.

Astrobioethics is the discipline inside astrobiology that studies not only the morality of all activities related to the presence of life on other worlds, but also studies our attitude towards the expansion of terrestrial life in the Universe. The discipline that focuses on moral problems is ethics; however, as ethics is not an exact science but rather a branch of philosophy, its problematic nature makes its content always updated according to the social context in which it operates. However, this does not stop the effort to reflect on the problems that ethics is facing within the framework of astrobiology (Wilson and Cleland, 2015).

The amount of information and papers about ethics is so abundant that it has been decided to circumscribe it only to those that work on astrobioethics issues, especially those related to the topics in this paper, because it focuses on aspects relevant to astrobiology only, differentiating them from astroethics, because the latter can expand its point of interest towards environments or situations where life does not exist, such as the moral approach of expanding the Planetary Protection Policy to areas with no life presence (Schwartz, 2018). However, we can rightly think that both are within the Ethics of Space, but due to the specialization of each one, this categorization is necessary. Still, it may be difficult to differentiate astroethics from astrobioethics. In order to establish it more easily, we can use the topics of the Astrobiology Roadmap (Des Marais *et al.*, 2008) and Astrobiology Strategy (Hays, 2015). If there are moral problems that intersect fundamental aspects presented in these guidelines, they will belong to the scope of astrobioethics, while astroethics can be seen as the treatment of space moral problems in general terms, including scenarios where there is no life presence.

The aim of this paper is to examine astrobioethics from the epistemological, religious and societal dimension. Other works like Schwartz and Milligan (2016) explore many aspects related to ethics and astrobiology, which is why this work represents an adequate complement to this type of research. That is important because it allows us to know what we prioritize and how we think about these issues (Stoeger *et al.*, 2013). There are great possibilities in this new field of knowledge because it let us know the state of the philosophical question, whether they come from professionals in natural sciences or humanities. Also, establishing a thematic arrangement will allow us to orientate easily in the discussion, helping us to establish a consensus about the terminology we should use; and finally making it easier to pose imaginary scenarios or mental experiments (Milligan, 2016*a*, 2016*b*), which will let us, in turn, to generate concepts and increase the initial thematic categorization.

The organization of this paper is as follows: the first part is focused on astrobiocentrism (epistemological dimension); here I discuss the paradigmatic approach we have about our place in the cosmos and our ethics. That is to say, the debate of our place in the Universe from a philosophical point of view in an epistemic context and how this affects ethics. The second part is the astrobiological secularism (religious dimension), and its purpose is to examine the religious potential against astrobiology. That is, our place in the Universe from the point of view of religion and how it can influence astrobioethics. Finally, the third part is dedicated to the social aspect (or societal dimension), and its function is to show the importance of the improvement in our understanding of our place in the cosmos, so it can guide us to a

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[1]Professor at the Universidad de Lima. President and founder of the Peruvian Association of Astrobiology (ASPAST). Associate Member of the International Astronomical Union F3 Commission, and International Working Group on Astrobioethics of the International Association on Geoethics.

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situation of greater tolerance and coexistence. As long as the society is involved looking to know if we are alone or not in the Universe, we will have the opportunity to expand their mentality.

The three parts have in common that they approach ethics from different dimensions, and all share the curiosity to discover if we are alone or not in the Universe. In the process, ethics is re-evaluated and contextualized for a better application in the society in which we live. It is important to see how studying the moral aspect of our relationship with other lifeforms outside the Earth can allow us to improve our relationship with the terrestrial forms of life in which we share a common home.

Astrobiocentrism

One of the points debated in the moral aspect of astrobiology is what we can call the anthropocentric dependence. We cannot leave behind our human approach when trying to establish a moral and 'universal' policy (in the cosmic sense). We can say that one of the bases for an astrobiological ethics is to give up the so-called biogeocentrism (Chela-Flores, 2001, 2009; Aretxaga, 2004), a kind of astrobiological anthropocentrism that uses the concept of life taking the Earth as a reference. It is an ontological limitation, even though the effect of discovering evidence for extraterrestrial life would be as great as the impact of the Copernican and Darwinian revolutions (Davies, 1995). However, even if we detect and establish a contact, the dependency of the biogeocentric and anthropocentric worldview would still remain very strong. Something similar to what Wittgenstein (1986) said: 'If a lion could talk, we would not understand him' (p. 225). Even if we share the language, we might not share the worldview and hence the sense given to things. In other words, it is impossible to leave our mentality of human beings; however, we try to be empathetic with other lifeforms.

This idea is very powerful. If we extrapolate it to the astrobiological field, we could even say that this is a possible answer to the Fermi's paradox (Webb, 2015), because we could not understand other forms of communication, and as a result we believe that we perceive nothing. Perhaps the means of communication used by an extraterrestrial intelligence is not understandable – but still identifiable – by us.

We cannot understand a lion because he does not use our language nor has the ability to do so, but if we imagine that we could, we still could not understand his world because we could not comprehend the way he sees it. Finally, if he could use our language and comprehend our worldview, he would stop being just a lion (not the physical form but in mentality)[2]. For this reason, it is ironic that for some people it is easier to establish a moral status of extraterrestrial life as long as they are assumed as intelligent beings, than to do so with respect to terrestrial animals with which we share the same ecosystem (Cleland and Wilson, 2013). We hope that intelligence is universal and that any other intelligent being assumes positions or processes thoughts in a similar way. It is assumed that there is a Kantian way of universal reason *a priori*.

This makes us doubt if we will ever overcome this ontological barrier. We are sure that if we find a second genesis (McKay, 1990; McKay, 2009), our ethical approach to life in the Universe will change. It could help us to build the arguments for an astrobiocentric paradigm. But what is this ontological barrier really? It is at the same time epistemological and ontological, even if we would like to try to think like other species, we will not totally succeed. But we could say that through transhumanism this can be done, but we do not know it yet, it is not well developed. The sure thing is that as human beings, it is a great achievement that we feel compassion and empathy for other species. We stop thinking only about ourselves, but we try to help from our human perspective and it can really cost us to get closer to understand the real need of other beings. It does not mean that having this limitation is justified. Quite the contrary, in order to live properly and in a certain harmony with our environment, we must make this effort; otherwise we can put ourselves in danger because we do not know how to live together with our environment and the beings that inhabit it. Our anthropomorphizing tendency is inevitable, we are conditioned by what we are; and an astrobiocentric ethic should aspire to account for these issues in order to be as universal as possible and not only focus on reason.

A rather interesting idea about our place in the Universe is the reason-centred perspective, where the rational aspect is the one that gives the greatest moral relevance to the species (Smith, 2007, 2009). However, as pointed out by Smith (2014), this would not be enough because we also have to consider the social and cultural aspects, which is called the sociality-reason-culture triad (SRCT). Just as there is a more appropriate way in which a species can adapt to an environment (as in the case of the aquatic beings to water), there would also be an adequate form of rational adaptation, and this species would eventually become more complex (Smith, 2014).

> What if the development of reason, society and culture is predictable in this way? What if they evolved on Earth not just because of a contingent set of initial conditions which may or may not be found on other planets, but because such constellation of abilities is favored in general by evolutionary processes? (Smith, 2014)

In fact, we can identify two versions of the SRCT proposal: the strong and the weak one. If we accept that every rational species can become more complex we could obtain the SRCT (strong version), our level of empathy would increase. On the other hand, we can also say that, although we have similar socio-cultural evolutionary similarities, our ontological limitation would only allow us to think that we are similar to them just in analogous ways, but never to achieve universal ethics (weak version).

On the other hand, an interesting term for astrobioethics is that of teloempathy, pointed out by Charles Cockell. Teloempathy comes from the conjunction of telos – from the Greek word telos that means finality – and empathy. The purpose of this ethics is the empathy for other extraterrestrial species, regardless of its origin. For example, if a Martian bacterium is discovered, it would have some value by itself due to teloempathy (Cockell, 2005*a*, 2005*b*, 2011). The idea of telos must not be understood as an *a priori* goal but as a teleonomic process, 'processes that owe their goal directed to the influence of an evolved program' (Mayr, 2004, p. 242).

This concept does not overcome the limitation of our biogeocentric conception, but rather brings us closer to an astrobiocentric understanding. This is best presented in the three essential characteristics of teloempathy. The first one is that we identify a form of life different from us and we cannot totally understand its functioning; that does not deny the fact that it has value in itself, even though we still do not have full knowledge

[2]This not happens when we learn different cultures because in that scenario we share the same species.

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of what life is. Second, it represents an extrapolation of the bioempathy that is already applied on Earth. That is, mutatus mutandi, teloempathy is a form of cosmocentric ethics (better emphasized as astrobiocentric). Finally, in the third place, this ethical approach does not change if life comes from Earth or from another planet. The ethical theoretical framework remains the same (Cockell, 2005*b*).

As can be seen, one of the ethical bases of astrobiology would be to recognize the ontological limitations of the human being with respect to ethics. But this is not an obstacle to establishing an astrobiocentric ethics based on teloempathy. In other words, the ethical discussion in astrobiology is taking us to an interesting reflection about us and our relationship with other living beings: teloempathy. In addition, it can help us to better understand our relationship with the beings with whom we already share an ecosystem. The ethics of astrobiology represents a great potential to optimize our understanding of our moral relationship with animals.

On the other hand, moral in astrobiology must go beyond the rational aspect, that is, also contemplate what was discussed – the SRCT – if we want to achieve a position that is as universal as possible, and be more flexible about the Kantian attempt of a universal reason. Of course, if we really want to consider a 'universal' ethic in the most real sense possible, it should be based on the experience and the cases studied, so that we avoid a metaphysical attempt that can bring us difficulties rather than solutions.

Secularism in astrobiology

When talking about the ethical aspect of the presence of life in the Universe, it is inevitable to mention the religious approach. An astrobiological ethics or astrotheology should work on the basis of the moral principles that govern different religions at present (Peters, 2014). The debate in this regard is important, given that there has even been an attempt to extrapolate or extract the elements that would be most relevant from Buddhism and Hinduism to an astrobiological code of ethics.

> While Buddhism lays emphasis on dependent co-arising, the illusion of the self as a distinct identity, Hinduism underscores the common source of origin and interrelatedness of all beings for continued existence. Both of these ancient religious traditions are fertile terrain to take ethics beyond conventional anthropocentric ethical paradigms toward astroethics (Irudayadason, 2013).

There are attempts to elaborate a kind of eclectic ethic based on the interests of astrobiology. Obviously, this is an example of how concepts are restructuring, rearranging, categorizing and even reinventing.

> With the Judeo-Christian religion there is also an issue about if there is life in other worlds. Is it possible that that Christ was born in them? the astrotheologian should ask whether it makes more sense to posit a single incarnation on Earth or multiple incarnations, each a planet-specific incarnation. The question of multiple incarnations is a reasonable one, but not if the option to rely upon a single incarnation appears to justify geocentrism or Earth chauvinism (Peters, 2014, p. 449).

How important is it for a religion, like the one mentioned, that Christ has or has not been present in other places in the Universe? It is a metaphysical question, but it holds for implicit the fact that it is a type of confirmation that the Universe manifests the glory of God (Losch, 2016). Also,

> Such a discovery would simply bring into clearer focus an existing set of questions in the ongoing theological enterprise, based on the theological interpretation of naturalistic explanation that since the time of Darwin has come increasingly to characterize that enterprise. (Knight, 2013, p. 253)

On the other hand, there is a certain type of uncertainty on how the religions of the world will react to the evidence of extraterrestrial life. In this, Peters (2014) is right when he mentions that we must be conceptually prepared. However, is it necessary for astrobioethics to feed on religion in the ethical aspect?

> The word religion comes from the Latin religare which means 'to bind together'. Religion in this sense would be the construct that allowed us for a long time to unite our world, giving shape and meaning, giving us a character of teleological beings, or beings that seek a purpose, which is not given a priori but is rather developed (Atlan, 2009).

In this sense, the meaning of *religare* can be lived in a game, in the theatre, in what we do, it is what makes us feel life makes sense. Of course, this is a subjective experience, as is the religious experience.

Should astrobiological *religare* be dependent on existing religions? Not necessarily. We must make the difference between religious and scientific interpretation insofar as they belong to two ways of understanding reality. Each one has its rules and infringing them could cause a certain level of reductionism, for example, if the scientific aspect tries to invade the terrain of religion, we may have as a result the ETI Myth (Peters, 2008, 2009, 2013, 2014):

> The essence of the ETI myth is that science saves: science can save Earth from its inadequacies, its evolutionary backwardness, and its propensity for self- destruction. And if terrestrial science is insufficient to save Earth, then extraterrestrial science just might be sufficient (Peters, 2014).

The ideological reductionism of any religion or belief should be strictly avoided when taking a position on the presence of life in the Universe within astrobiology. Beliefs are personal and should remain as such. They can be tolerated and understood, but astrobiology as a science must remain neutral in front of these worldviews. The astrobiologist must understand that this is a matter of moral importance from the moment in which one does not want to impose any religion on another. The neutrality of science in the face of religious beliefs must be present and recognized in astrobiology. The response of astrobioethics to religious dilemmas must manifest a secular position.

However, talking about religion and its role in astrobiology would require not only a complete article, but even a book. Scientists are people who may or not have beliefs. When they perform experiments, they know that their results do not depend on their faith since the process is different – or at least that would be expected. However, when the topic is not strictly scientific but ethical, there may be a problem since it does not depend on a scientific method but on the arguments that are established. While these arguments are based on evidence, the process of ethical debate may be clouded by religious ideology.

Each religion has a set of principles and rules that exclude one religion from another. They may have aspects in common as in the Abrahamic religions, but that does not mean that Judaism ceases to be so to become another religion. As long as each religion maintains its position and does not allow any exception or modification in its belief system, it will not be possible or very

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difficult to establish a position in which all agree. Another alternative might be that other types of religious practices arise to satisfy society including our interest to know if we are alone or not in the Universe, and thereby assume a moral position. Regarding the latter, time will tell us.

Responsibility with society

To be able to examine this third part, we can use two NASA documents as a main input. The first one is the Astrobiology Strategy (Hays, 2015) and the Astrobiology Roadmap (Des Marais *et al.*, 2008). Of course, there are other documents such as the ones proposed by Impey *et al.* (2013), Chon-Torres (2018*a*, 2018*b*), Peters (2014), Horneck *et al.* (2016), Race and Randolph (2002), Race *et al.* (2012), Capova *et al.* (2018), which will also serve us for this analysis, since they are also relevant to the multidisciplinary nature of astrobioethics.

In the first place, in the Astrobiology Roadmap, there are four bases whose epistemological content is quite interesting and that are synthesized in the following way:

(1) The multi and interdisciplinary nature of astrobiology.
(2) The importance of ethics in front of the challenge of biologically contaminating other worlds or our own planet.
(3) The social relevance of astrobiology.
(4) The importance and educational potential of astrobiology, both formally and informally (Des Marais *et al.*, 2008).

As previously shown, in this section, our interest is going to focus on the last two principles: social relevance and educational potential. We must also add other relevant aspects pointed out by the Astrobiology Strategy (Hays, 2015): it presents a series of questions that should address the humanities and the social sciences. One of them, for example, is what is the interest of the researchers outside of the natural sciences with astrobiology; another is the extent to which the public is interested in astrobiology; as well as the opportunities to establish a relationship between disciplines through astrobiology (Hays, 2015).

The millennial question of whether we are alone or not in the Universe intersects astrobiology. Since this is a science and its modus operandi can possibly give us answers based on evidence (unlike pseudoscience or other beliefs), just a small but irrefutable evidence for life on another planet would make a mark before and after in the history of science and humanity. A challenge faced by researchers in astrobiology is that they cannot cope with one discipline alone.

It is necessary to coordinate different methodologies and disciplinary perspectives (Race *et al.*, 2012). This highlights the transdisciplinary nature of astrobiology (Santos *et al.*, 2016; Chon-Torres, 2018*a*) not as unifying itself, which is methodologically impossible because each discipline has its characteristics that must be respected; but as a manager of knowledge according to the scenario (United Nations Educational, Scientific and Cultural Organization, 1998; Leavy, 2011).

Astrobiology does not represent a literal unification of sciences because the methodology that each discipline practices is not homologated with the others. For example, the methodology used for psychology in space exploration differs from the one used in astrophysics. Due to the disciplinary nature of each science, its object of study is approached in a different way. The set of rules and principles that do not allow this unification is called nomological network (Chon-Torres, 2018*a*). We can say the same for astrobiocentrism also.

This, connected with the responsibility of astrobiological communication towards the public 'leads to unique opportunities for scientific education and outreach, but also calls for critical assessment of whether and in what ways astrobiologists answer the questions the public is asking' (Hays, 2015). This is achieved from different approaches and points of view, for which the educational-social potential of astrobiology is imperative, since it shows us how to collaborate in *a posteriori* context exploring unknown territories.

> Astrobiology is an interdisciplinary subject that draws from research in astronomy, biology, biochemistry, chemistry, geology, microbiology, physics, and planetary science, a non-exhaustive list. It also touches upon the disciplines of history, philosophy, and sociology. Education in astrobiology therefore helps students develop the awareness that all sciences are related (Kwok, 2018).

This helps to exercise the critical eye in the students or the aspirant astrobiologists. It can be applied at school, university and general public level when communicating with the people the progress in the astrobiological field (Rummel *et al.*, 2012). The content of formative research of this scientific discipline is relevant. We can also see it in the White Paper written in order to discuss the basis of a European astrobiology institute:

> One of the major challenges for research concerning astrobiology and society is interdisciplinarity, finding opportunities for interdisciplinary/multidisciplinary collaboration both between science and the humanities/social sciences and between disciplines within the humanities/social sciences. A further challenge is integrating relevant research within the humanities/social sciences that can contribute towards research concerning the societal implications of Astrobiology (Geppert *et al.*, 2018).

The importance of the humanities and their role within the ethical guidelines of astrobiology is undeniable because ethics itself belongs to the field of humanities. Ethics is a branch of philosophy that is responsible for studying the moral content of our actions and analysing the theoretical content of normative morality.

If we want to establish a code of astrobiological ethics, this will not arise only from the natural sciences, but also from establishing a deep connection with the humanities. In other words, in order to obtain an adequate result in humanistic terms and with appropriate bases for an astrobiological regulatory ethic, it is essential to establish bridges of communication with the humanities.

If we consider that each specialist has a particular training, where the specialization of knowledge predominates, we can say that there is a tendency to have 'microwisemen'. The challenge is to overcome this reductionist mentality. For example, if we are very close to the natural sciences, the humanities may even seem like a kind of 'soft' knowledge – positivist prejudice – but if this prejudge is overcome then we will realize that the effort has been worthwhile. The researchers involved in the humanities, as well as the natural sciences, will discover new dimensions of the object of study in question, multiple nuances that will be relevant contributions for the research (Vilar, 1997). Optimizing the quality of this connection will help the astrobiology researchers with the communication towards society.

> Astrobiology has clear existential implications, but beyond these, it also has concrete cultural, ethical, societal, educational, political, economic,

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> and legal consequences. How will the general public react if we discover life on another planet? What pedagogic role can astrobiology play in elementary and higher education? To what extent should we utilize space for commercial and industrial purposes? How should this be politically managed and how should it be legally regulated? (Dunér *et al.*, 2018)

The problems posed by the humanities within the astrobiology are those that represent a social and educational interest. They share interests of the same nature.

> The search for extraterrestrial life is a good test case since it is a field that evokes much interest among students as well as the general public, and since it is a field that encompasses many different scientific disciplines and even deals with questions that need to be considered in a wider societal context (Perssone*t al.*, 2018).

Therefore, an astrobiological ethic will consider these aspects from a point of view of coordination rather than unification. In this way, we can see that the establishment of a possible astrobioethics roadmap will come not only from specialists in astronomy, biology or physics, but also from philosophers, sociologists and lawyers. An astrobiological ethics should know how to handle this, since many of the disciplines involved have their own methodology of work.

Peace and planetary sustainability

The promotion of planetary peace and sustainability is an idea that can be found within the bibliography which deals with the establishment of ethical criteria in astrobiology. As a background, we can mention the Space Treaty (United Nations, 2002) of 1967, where it explicitly promotes the peaceful use of knowledge for space exploration. This is important because we must not take our conflicts to outer space; we must not use it for purposes that endanger our presence in outer space. Section A 4 of the Space Treaty states the following:

> The activities of States in the exploration and use of outer space shall be carried on in accordance with international law, including the Charter of the United Nations, in the interest of maintaining international peace and security and promoting international cooperation and understanding (United Nations, 2002).

Within the support for a possible astrobiological code of ethics, we must mention the peaceful purposes that any research with astrobiological potential should have. Unfortunately, this is a point that is scarcely highlighted in the existing literature on ethics and life in space. Promoting peace and planetary sustainability represents one of the topics worth considering, in order to have a complete picture of the following formulation of the astrobiological code of ethics. Regarding planetary sustainability, we can see the following in Losch (2018):

> I am convinced, in the developing Space Age the issue of sustainability must be reframed in this way. Obvious to the scientist, Earth does not float in an empty void, but is part of a universe, surrounded by billions of billions of space objects The idea of planetary sustainability in Mars can be thought of as an extension of what is used on Earth. An astrobiological science must respect criteria of sustainability in space when, for example, there is an attempt to generate a space mining industry (Losch, 2018).

NASA has proposed three principles to understand planetary sustainability, and they can serve as a reference point:

(1) A world in which all people have access to abundant water, food and energy, as well as protection from severe storms and climate change impacts.
(2) Healthy and sustainable worldwide economic growth from renewable products and resources.
(3) A multi-planetary society, where the resources of the Solar system are available to the people of the Earth (NASA, 2014).

Specifically, the last point can be promoted by astrobiology while, even though there is no evidence of life on other planets, it represents a possibility to think of us as beings that share a single planet. We can also see this idea expressed in Crawford 'humanity has a responsibility to develop international social and political institutions appropriate to managing the situation in which we find ourselves' (2017). In an international political context in which fragmentations can become increasingly pressing due to the interests of each nation, astrobiology reminds us that we are, perhaps, the only living beings in the Universe; and if we are not, then we share the same origin (Crawford, 2017).

For this reason, aspects such as planetary sustainability go along with the search for peace and union with our own humanity and with the other species that share a biological origin. That is why, it is striking that the word 'peace' is not found regularly or abundantly in the astrobiological literature.

If we think about the Planetary Protection Policy (Kminek and Rummel, 2015), we also need to incorporate in it the idea of sustainability and the search/promotion of planetary peace. The idea of a planetary peace is presented to us as an idea since it would not be very realistic to think of it as total peace, but its promotion should be included in an astrobiological code of ethics. We see that, for example, Cockell (2005*a*), Randolph and Mckay (2014) and Cockell and Horneck (2004) express ways of trying to complete the panorama of Space Policy. Even Cockell (2016, 2008) goes beyond and raises the possibility of elaborating a new theoretical framework for how we understand the idea of freedom and the idea of managing the population of future human settlements on another planet, and the same line but with a different conclusion does Milligan (2016b). This last contribution is a step forward in the search for better societies through astrobiological research. However, all this should complement a future proposal of an astrobioethics code.

A positive signal that goes in the right direction is the 2018 report of the Office for Outer Space Affairs, where it is declared that the development of space technology must be oriented towards the achievement of sustainable development objectives. 'The view was expressed that all States conducting space activities should behave in a responsible manner in order to maintain the safety and the sustainability of outer space activities' (UNOOSA, 2018). In the same way, the astrobiological space exploration should also emphasize the creation of conditions to achieve a more self-sustaining society.

Perhaps the best way to summarize the relevance of sustainability and peace can be found in the famous words of Carl Sagan in his book *Pale blue dot*:

> Look again at that dot. That's here. That's home. That's us. On it, everyone you love, everyone you know, everyone you ever heard of, every human being who ever was, lived out their lives… every creator and destroyer of civilization, ever king and peasant, every young couple in love, every mother and father, hopeful child, inventor and explorer, every teacher of morals, every corrupt politician, every 'superstar,' every 'supreme

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> leader,' every saint and sinner in the history of our species lived there—on a mote of dust suspended in a sunbeam (Sagan, 1997)

This rightly connects with the astrobiocentric perspective, because it tries to go beyond personal ontological and biological limitations. Thus, the proposals that encompass the three thematic axes feed one another, allowing the researcher or the institution to organize and categorize the necessary concepts for a possible adequate formulation of what could be considered an astrobioethical roadmap.

Conclusions

It is not easy to draw conclusions in a field that is still under development, as we have seen. We can say that from each aspect there are attempts that if taken separately we would believe that they already have a way to the solution. However, seen together and compared to each other, the aspect we have is that of various opinions that still do not find a common channel. For example, we have an approach to what we can consider one of the first astrobioethics principles, teloempathy. It is not entirely clear if we are ever going to completely develop it due to our very condition of being human beings, but at least is an advance for developing a moral position in front of other forms of life. On the religious aspect, we have seen that it is so complex that it is difficult to define a common position in all of them due to the exclusive nature of each one. Finally, the societal aspect is showing us that astrobiology has the potential to broaden our perspectives and improve our mentality. It can lead us to a culture of more tolerance and peace because it interweaves the millennial interest in knowing whether we are alone or not in the Universe. At the same time, the educational potential is great because it also allows us to connect topics in order to give a more integral solution to what we face. All these are a clear example of how studying the cosmos implies a better knowledge of ourselves, an essential part of astrobioethics.

Author ORCIDs. Octavio A. Chon-Torres, https://orcid.org/0000-0003-3905-6784.

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References

Aretxaga R (2004) Astrobiology and biocentrism. In Seckbach J, Chela-Flores J, Owen T and Raulin F (eds), *Life in the Universe*. Dordrecht, The Netherlands: Kluwer Academic, pp. 345–348.

Atlan H and Thompson WI (2009) *Gaia*, 5th edn, Barcelona: Kairós, pp. 107–123.

Capova KA, Persson E, Milligan T and Dunér D (2018) *Astrobiology and Society in Europe Today*. Berlin: Springer International Publishing.

Chela-Flores J (2001) *The New Science of Astrobiology from Genesis of the Living Cell to Evolution of Intelligent Behavior in the Universe*. Dordrecht, The Netherlands: Kluwer Academic.

Chela-Flores J (2009) *A Second Genesis: Stepping Stones Towards the Intelligibility of Nature*. Singapore: World Scientific.

Chon-Torres OA (2018*a*) Disciplinary nature of astrobiology and astrobioethic's epistemic foundations. *International Journal of Astrobiology*, 1–8. DOI: 10.1017/S147355041800023X.

Chon-Torres OA (2018*b*) Astrobioethics. *International Journal of Astrobiology* **17**, 51–56.

Cleland C, Wilson E, Impey C, Spitz A and Stoeger W (2013) *Encountering Life in the Universe: Ethical Foundations and Social Implications of Astrobiology*. Arizona: University of Arizona Press, pp. 17–55.

Cockell C (2005*a*) Planetary protection – a microbial ethics approach. *Space Policy* **21**, 281–292.

Cockell CS (2005*b*) Duties to extraterrestrial microscopic organisms. *Journal of the British Interplanetary Society* **58**, 367–373.

Cockell C (2008) Essay on extraterrestrial liberty. *Journal of the British Interplanetary Society* **61**, 255–275.

Cockell CS (2016) Disobedience in outer space. In Cockell CS (ed.), *Dissent, Revolution and Liberty Beyond Earth*. Cham: Springer International Publishing, pp. 21–40. https://doi.org/10.1007/978-3-319-29349-3_3.

Cockell C and Horneck G (2004) A planetary park system for Mars. *Space Policy* **20**, 291–295.

Cockell C, Landfester U, Remuss N-L, Schrogl K-U and Worms J-C (2011) *Humans in Outer Space – Interdisciplinary Perspectives*. Berlin: Springer, pp. 80–114.

Crawford I (2017) Widening perspectives: the intellectual and social benefits of astrobiology (regardless of whether extraterrestrial life is discovered or not). *International Journal of Astrobiology* **17**, 57–60.

Davies P (1995) *Are We Alone?*. New York: BasicBooks.

Des Marais D, Nuth JA III and Allamandola LJ (2008) The NASA astrobiology roadmap. *Astrobiology* **8**, 715–730.

Dunér D, Capova KA, Gargaud M, Geppert W, Kereszturi A and Persson E (2018) Astrobiology and society in Europe. In Capova KA, Persson E, Milligan T and Dunér D (eds). *Astrobiology and Society in Europe Today*. Berlin: Springer International Publishing.

Geppert W, Dunér D, Hemminger E, Kaňuchová Z and Waltemathe M (2018) Education, training and scholarship. In Capova KA, Persson E, Milligan T and Dunér D (eds). *Astrobiology and Society in Europe Today*. Berlin: Springer International Publishing.

Hays L (ed.) (2015) The astrobiology strategy 2015. Available at https://nai.nasa.gov/media/medialibrary/2015/10/NASA_Astrobiology_Strategy_2015_151008.pdf.

Horneck G, Walter N, Westall F, Grenfell JL, Martin WF, Gomez F and Capria MT (2016) Astromap European Astrobiology Roadmap. *Astrobiology* **16**, 201–243. http://doi.org/10.1089/ast.2015.1441.

Impey C, Spitz A and Stoeger W (2013) *Encountering Life in the Universe: Ethical Foundations and Social Implications of Astrobiology*. Arizona: University of Arizona Press.

Irudayadason NA (2013) The wonder called cosmic oneness toward astroethics from Hindu and Buddhist wisdom and worldviews. In Impey C, Spitz A and Stoeger W (eds). *Encountering Life in the Universe: Ethical Foundations and Social Implications of Astrobiology*. Arizona: University of Arizona Press.

Kminek G and Rummel J (2015) Space Research Today, COSPAR's information bulletin. COSPAR's Planetary Protection Policy (193). Available at https://cosparhq.cnes.fr/sites/default/files/ppp_article_linked_to_ppp_webpage.pdf.

Knight CC (2013) Astrobiology and theology: uneasy partners? In Dunér D, Parthemore J, Persson E and Holmberg G (eds), *The History and Philosophy of Astrobiology*. Newcastle: Cambrige Scholars Publishing.

Kwok S (2018) Astrobiology as a medium of science education. In Kolb VM (ed). *Handbook of Astrobiology*. Boca Raton, FL: CRC Press Taylor & Francis Group.

Leavy P (2011) *Essentials of Transdisciplinary Research: Using Problem-Centered Methodologies (Qualitative Essentials)*. [Kindle version]. California: Left Coast Press.

Losch A (2016) Astrotheology: on exoplanets, Christian concerns, and human hopes. *Zygon* **51**, 404–413.

Losch A (2018) The need of an ethics of planetary sustainability. *International Journal of Astrobiology* **18**(3), 1–8. 10.1017/S1473550417000490.

Mayr E (2004) *What Makes Biology Unique?* Cambridge University Press.

McKay CP (1990) *Does Mars Have Rights? An Approach to the Environmental Ethics of Planetary Engineering*. New York: Routledge.

McKay CP (2009) Biologically reversible exploration. *Science* **323**, 718 LP-718. Available at http://science.sciencemag.org/content/323/5915/718.abstract.

Milligan T (2016*a*) Common origins and the ethics of planetary seeding. *International Journal of Astrobiology* **15**, 301–306.

https://doi.org/10.1017/S147355041900017X Published online by Cambridge University Press

Milligan T (2016*b*) Space Ethics Without Foundations. In Schwartz JSJ and Milligan Tony (eds). *The Ethics of Space Exploration*. Berlin: Springer, pp. 109–123.

NASA (2014) Our vision for planetary sustainability. Available at http://www.nasa.gov/content/planetary-sustainability-our-vision/#.WBgtmiTBZsl.

Persson E, Capova K and Li Y (2018) Attitudes towards the scientific search for extraterrestrial life among Swedish high school and university students. *International Journal of Astrobiology* **18**(3), 1–9. 10.1017/S1473550417000556.

Peters T (2008) *The Evolution of Terrestrial and Extraterrestrial Life*. Goshen, IN: Pandora Press.

Peters T (2009) Astrotheology and the ETI Myth. *Theology and Science* **7**, 3–30.

Peters T (2014) Astrotheology: a constructive proposal. *Zygon* **49**, 443–457.

Peters T, Impey C, Spitz A and Stoeger W (2013) *Encountering Life in the Universe: Ethical Foundations and Social Implications of Astrobiology*. Arizona: University of Arizona Press.

Race M and Randolph O (2002) The need for operating guidelines and a decision making framework applicable to the discovery of non-intelligent extraterrestrial life. *Advances in Space Research* **30**, 1583–1591.

Race M, Denning K, Bertka CM, Dick SJ, Harrison AA, Impey C, Mancinelli R and Workshop Participants (2012) Astrobiology and society: building an interdisciplinary research community. *Astrobiology* **12**, 958–965.

Randolph R and McKay C (2014) Protecting and expanding the richness and diversity of life, an ethic for astrobiology research and space exploration. *International Journal of Astrobiology* **13**, 28–34.

Rummel JD, Race MS, Horneck G and the Princeton Workshop Participants (2012) Ethical considerations for planetary protection in space exploration: a workshop. *Astrobiology* **12**, 1017–1023.

Sagan C (1997) *Pale Blue Dot. A Vision of the Human Future in Space*. New York: Ballantine Books.

Santos C, Alabi L, Friaça A and Galante D (2016) On the parallels between cosmology and astrobiology: a transdisciplinary approach to the search for extraterrestrial life. *International Journal of Astrobiology* **15**, 251–260.

Schwartz JSJ (2018) Where no planetary protection policy has gone before. *International Journal of Astrobiology*, 1–9. https://doi.org/10.1017/S1473550418000228.

Schwartz J and Milligan T (eds) (2016) *The Ethics of Space Exploration*. Berlin: Springer.

Smith KC (2007) Cosmic ethics. Workshop Report. In Bertka C, Roth N and Shindell M (eds), *Philosophical, Ethical, and Theological Implications of Astrobiology*. Washington: AAAS.

Smith KC (2009) The trouble with intrinsic value: an ethical primer for astrobiology. In Bertka C (ed). *Exploring the Origin, Extent, and Future of Life: Philosophical, Ethical, and Theological Perspectives*. Cambridge: Cambridge University Press.

Smith KC (2014) Manifest complexity: a foundational ethic for astrobiology? *Space Policy* **30**, 209–214. https://doi.org/10.1016/J.SPACEPOL.2014.10.004.

Stoeger W, Impey C, Spitz A, Impey C, Spitz A and Stoeger W (2013) *Encountering Life in the Universe: Ethical Foundations and Social Implications of Astrobiology*. Arizona: University of Arizona Press.

United Nations (2002) *United Nations Treaties and Principles on Outer Space*. New York: Author.

United Nations Educational, Scientific and Cultural Organization (1998) Transdisciplinarity. Available at http://unesdoc.unesco.org/images/0011/001146/114694Eo.pdf.

UNOOSA (2018) Committee on the peaceful uses of outer space: 2018. Available at http://www.unoosa.org/oosa/en/ourwork/copuos/2018/index.html.

Vilar S (1997) *La Nueva Racionalidad*. Barcelona: Kairós.

Webb S (2015) *If the Universe Is Teeming with Aliens … Where is Everybody?*. Berlin: Springer Nature.

Wilson E and Cleland C (2015) The moral subject of astrobiology: guideposts for exploring our ethical and political responsibilities towards extraterrestrial life. In Dick S (ed.), *The Impact of Discovering Life beyond Earth*. Cambridge: Cambridge University Press, pp. 207–221.

Wittgenstein L (1986) *Philosophical Investigations*. Oxford: Basil Blackwell.

https://doi.org/10.1017/S147355041900017X Published online by Cambridge University Press