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Astrobioethics

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Abstract: Astrobiology is a discipline that is expanding its field of investigation not only in the natural sciences, but also in the social sciences. It is for this reason that the ethical aspects are progressively emphasized leading to a point where the whole field requires a specific handling. The appellation 'astrobioethics' is now considered as not only relevant, but also a true issue for the future of Astrobiology. Astrobioethics is the subsection within astrobiology that is accountable for studying the moral implications of, for example, bringing humans to Mars, the Planetary Protection Policy, the social responsibility of the astrobiologist to society, etc. It is in this way that the present article outlines a path for astrobioethics, as being a fertile field of study and an opportunity to trade scientific knowledge in a transdisciplinary way.

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As you explore communication in astrobiology don't forget the humanities: exploring space is not only a scientific problem

Sanjoy Som, 3rd International Congress of Astrobiology in Manizales, Colombia

Astrobioethics is an interdisciplinary field of astrobiology and ethics; it studies the ethical implications of astrobiological research. However, astrobioethics must have transdisciplinary practices in order to enrich itself and propose a broader judgement according to the context where it is applied. As an *emergent* discipline it is necessary to establish its philosophical foundations, so that it can rely on a theoretical framework for its awareness as a field of knowledge. Astrobioethics presents itself as a necessity for astrobiology, which is having new and more advances on many different scientific grounds, for that reason it is essential to lay a series of fundamental questions that allow us to foresee with better clarity the current necessities this new discipline may propose.

On the international agenda, astrobioethics is gradually increasing, for example, the 'International Working Group on Astrobioethics' was founded on 3 January 2016 within the framework of the activities of the International Association for Geoethics (International Group on Astrobioethics 2016), thus being the first time that the astrobioethic subject is treated through an academic work group. On the other hand, within the 35th International Geological Congress celebrated in South Africa, the relevance for astrobiology of including ethics, astrobioethics, (Martínez-Frías & Gargaud 2016) was discussed. These antecedents tell us that this new discipline is taking more and more importance, so it becomes essential to begin to explain and delimit its nature.

Due to technological limitations, Astrobioethics can be developed through mental experiments, which will remarkably differentiate it from all kinds of excessive speculations that are typical of pseudo-sciences. Mental experiments are a way to help us to extend the meaning and use of certain concepts in order to understand new scenarios towards which we have not yet arrived, but which will be present within the astrobiological framework, such as inhabiting (or 'colonizing') Mars, its consequences for the Ecology of the red planet and many issues related to them.

No one has gone to Mars yet, but it is a problem that should be examined by the Policy of Planetary Protection (PPP) given the potential damage that can be caused to the life that could exist there and that we have not yet been able to detect. The damage would be irreparable and would take away the opportunity to know whether we are alone or not in the Universe, at least at the modest scale of our own Solar System and for the present time. This, indeed, requires time and patience. A strong consensus is needed in order to establish a valuable reason to be sure that it is already possible to send people to Mars, even if we will never reach a true certainty. Sending humans to Mars cannot be only a technological problem, but astrobioethics can expand our vision and help us to make better decisions on planetary protection, for instance but also on many issues that may appear unrelated to the problem (global climatic change, renewable energy and food resources, and preservation of life on our own planet).

Astrobioethics has the versatility, critical analysis and global vision inherited from philosophy. Ethics is the branch of philosophy that studies moral acts and everything concerning its arborescence. Astrobiology is a transdisciplinary scientific discipline that studies the origin, the present and the future of life in the Universe using for the purpose of diverse methodologies that utilize the different disciplines that make it up. Astrobiology uses each of them in different contexts as the case may be, since it considers planetary sciences, biology,

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physics, chemistry, etc. Ethics is not a science, but it enables us to propose a critical analysis of the moral content that can be found in the decision making involving astrobiological aspects. Ethics can help us to establish consensus among the different opinions of scientists involved in making the decisions; and this makes ethics the precise tool to convert it into astrobioethics.

In this way, we identify some main items that can be developed in astrobioethics:

1. Legal Aspect: Policy of Planetary Protection;
2. Ethical Aspect: Human beings as guardians of life in the Universe;
3. Social Aspect: Social responsibility in the informative aspect.

Policy of Planetary Protection

In order to start talking about PPP, it would be good to mention a little bit of its background. A brief history of PPP is mentioned on the website of NASA's Office of Planetary Protection. There, it is pointed out that the first antecedent occurs in 1956 in the VIIth Congress of International Astronautic Federation in Rome (NASA Office of Planetary Protection 2016). It is interesting to note that a particular interest in this regard has started since the 1950s, despite not having at the time, the technology that is now at our disposal. In October 1958, the first Code of Conduct of Planetary Protection was developed by the Committee on Space Research (COSPAR), a key element that later would develop the PPP.

Special attention should be paid to the UN Committee on the Peaceful uses of Outer Space formed in December of the same year. This document develops a series of aspects on the protection of outer space involving the Moon and celestial objects. This document brings together five single-volume treaties on outer space accepted by the United Nations (UN). This creates an important precursor in the topic of the administration of space and celestial objects that can provide us insight in order to elaborate a similar document, but especially for Mars and perhaps the moon of Jupiter, Europa.

In this treaty, special emphasis on the peaceful use of the Moon and other celestial bodies is declared: 'The establishment of military bases, installations and fortifications, the testing of any type of weapons and the conduct of military manoeuvres on celestial bodies shall be forbidden' (UN, Article IV, 2002). This is a way to avoid exporting to other planetary environments the problems that we have on Earth, regarding nationalism and imperialism.

The treaty of outer space is a good example of how our expansion in the Universe should help us to conceive ourselves as a united humankind, which is also perceived in the deep sense of reflection that comes from seeing ourselves in an astrobiological standpoint. For this reason, the treaty elaborates: 'States Parties to the Treaty shall regard astronauts as messengers of mankind in outer space and shall render to them all possible assistance in the event of accident, distress, or emergency landing on the territory of another State Party or on the high seas' (UN 2002, p. 4–5).

Note the emphasis on the question of being the envoys from mankind, a transcendental aspect that must be part of astrobioethics as a promotion of the notion of a united planetary humankind, beyond the borders of the different States now ruling the planet. A moral pillar of astrobioethics can already be clearly seen and thus the foundations for this new discipline are being built.

On the other hand, the treaty indicates that in case a non-governmental entity wishes to explore outer space, it should be subject to the State party's control. However, it is not very specific in terms of sanctions or what should be done if a serious attempt is committed, such as accidentally destroying the possible life that inhabits the celestial object to which they want to land.

It is precisely because of this, that a PPP becomes necessary, which, at the time of writing, was not yet been drafted. In this treaty, special emphasis is placed on planetary protection in relation to the Earth, but there is no mention of the astrobiological interest in preserving possible extraterrestrial life. It should be noted that astrobiology as a research project and its subsequent disciplinary composition was only shaped in the mid-1990s, so it is understandable that this omission occurred.

However, some bases can be extrapolated that will be useful for astrobioethics, such as the fact that the Moon and its natural resources are patrimony of all mankind. The same thing we can say about Mars and whoever is 'born' on Mars, if that is the case. With current technology the problem of whether someone is born on Mars (or on any planetary sized body present in our Solar System, to remain for the moment, focused on possible exploration by technical means from planet Earth) is still a mental experiment, but it should be debated as an astrobioethic subject. If it is the case that someone is born on Mars, what will be his nationality? The country of his parents? Will he have planetary citizenship? What will be his rights? At the moment it is much too early to give a solution, but the intellectual exercise can prepare the ideas for when the moment arrives. This solution will need a transdisciplinary approach using the different sciences that astrobioethics requires. In history, we have a referent in the past with natural philosophy from the 17th to 19th century when colonization of America or India was performed.

The treaty emphasizes on the benefit that civilization can obtain through the use and exploitation of outer space. This can be used as a topic of debate for space mining, because if a company wishes to make use of resources from another planet or Moon for its own benefit, it would contradict the treaty. The treaty is clear about the use of outer space and celestial objects, all this must be used for the benefit of all humanity, 'Outer space and celestial bodies are not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means' (UN 2002, p. 39). A referent on Earth for this we have with Antartica resources.

That leaves us in doubt as to whether a private enterprise wishes to exploit certain resources in a celestial object, but cannot do so under the treaty. Would then be a hindrance to the development of the space industry? A deeper development of the particular case of the private sector in space exploration is needed; this is another subject that belongs to astrobioethics.

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Another interesting element on ethics in this treaty is that the exploration of outer space must also pay attention to the benefits of developing countries. 'It shall be carried out for the benefit and in the interest of all States, irrespective of their degree of economic, social or scientific and technological development, and shall be the province of all mankind. Particular account should be taken of the needs of developing countries' (UN 2002, p. 56). The social and cultural question cannot be left aside if one wants to develop an authentic astrobioethic; one cannot exclude the humanities in the space exploration, since it would lock us up in a bubble and make us insensible to the human condition.

Subsequently in 1964, the COSPAR developed the PPP that would address biological aspects that were not raised in the Outer Space Treaty of the UN. Since then the PPP has had changes and updates. The COSPAR is an interdisciplinary group that belongs to the International Council of Scientific Unions (ICSU). The COSAPR's PPP is constantly updated through an arduous process and debate, which is presented in this article that corresponds to March 2011 (Kminek & Rummel 2015).

COSPAR is based on the Outer Space Treaty, particularly in the Article IX. The five categories to accomplish this task refer, in synthesis, to the following:

Category I. It includes all the missions that are of no interest for the study of the chemical evolution of life. There is no need to apply the PPP in this case.

Category II. They are all the missions that may represent a relative interest for the evolution of life, with a remote probability that a spacecraft landing there compromises it for future investigations. A brief documentation of the PPP plan, prelaunch and post report, post-match report and end-of-mission report are required.

Category III. It includes some types of missions such as orbiting objects that have astrobiological interest and that when having contact with the object of study may compromise future research. Although it does not imply contact with the object, it is relevant to take the measures in case a contact happens.

Category IV. These are the missions involving rovers or probes landing on celestial objects that have a high astrobiological interest for the understanding of life in the Universe. The protocol for the assembly of these artefacts must be done with extreme care following the respective indications, similar to those made with the *Viking* missions. Some places that involve Category IV are certain locations on Mars. The celestial objects of category IV are: Mars, Europa, Enceladus and others to be defined (but mostly icy satellites from giant planets, although Pluto may not be excluded from this list as well as any KBO objects).

Category V. In this category fall all the missions that involve a sample return to the Earth. This is in order to protect the Earth and the Moon (the Moon must be free from contamination, so it must be also protected by PPP in Earth–Moon trips). For bodies that are known by scientific consensus that they do not possess native life forms (the Moon for instance), the subcategory called 'unrestricted return to Earth' is generated (Kaminek & Rummel 2015, p. 3–4).

This document is very specific as to the protocol that must be performed for possible landings in order to avoid contaminating the planet to explore. There are specifications for missions to Mars; the amount of biological load should avoid possible contamination to the planet. The categories have subdivisions according to the needs of the PPP. In addition, there is a term called 'Special Region' which is referred to places where terrestrial organisms are likely to replicate; or places that also have a potential presence of Martian life (Kaminek & Rummel 2015, p. 7).

It is also interesting to observe what is said about the principles and guidelines for human missions to Mars. Whether it is with a robot or with humans, the PPP must be fulfilled, that is, it is not only limited to the aspect of human exploration (Kaminek & Rummel 2015, p. 8).

Following this, a group of general principles emerges that seek to care of the Earth from possible contamination issues, as well as keeping everything under control so as not to damage the astrobiological interest in the investigation when visiting Mars. It is also indicated that any Martian sites that have not been characterized must first be examined by a robotic mission (Kaminek & Rummel 2015, p. 8). Of course, they are procedures but the word 'ethics' is not mentioned throughout this document. Indeed, the COSPAR would represent an appropriate procedural and technical aspect on the contamination issues, but it does not contain any moral reflection. Astrobioethics must emphasize moral and ethical aspects in relation to the implications of both documents and the Outer Space Treaty such as COSPAR or other PPP developed by any space agency in the world. Returning to the COSPAR's PPP, the procedures to be performed also for Europa and Enceladus, and similarly with small bodies of the Solar System is specified there. For the latter case, six questions are applied when attempting to take samples on these objects (Kaminek & Rummel 2015, p. 10). They are protocolary ways of proceeding, but it is still an only technical aspect of astrobioethics.

On the other hand, in 2010 a COSPAR workshop dealt with the ethical aspects of the PPP in space exploration, a debate that may well enter in the category of astrobioethics. The workshop was held at Princeton University and had as its main points, to consider the ethical implications of exploring Mars, minimizing damage to the possible native biosphere; reviewing the current PPP; and how to engage the public in the ethics of space exploration (Rummel *et al*. 2012, p. 1018).

In this workshop, which was divided into two groups, ethical aspects related to the possibility of exploring Mars with robotics or human presence were addressed. It even raised the possibility of generating a sort of 'Planetary Parks', intangible areas to protect the possible (and may be very different) life that can harbour the red planet. It was noted that there is a need to improve the UN Outer Space Treaty but without modifying its approach, and that it is necessary to generate an ethical theoretical framework to address problems arising from space exploration (Rummel *et al.* 2012, p. 1019).

It also mentions the relevance that exists in raising public awareness on these debates and to include participants outside

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the classic scientific community to participate in the discussion on ethical aspects. In addition, participants agreed that it is important to discuss ethical issues given the potential of discovering extraterrestrial life, and the development of space exploration (Rummel, *et al.* 2012, p. 1019).

In synthesis, and for our case, this workshop claims the need to develop astrobioethics that can improve and extend the moral issues regarding the PPP and the Outer Space Treaty of the UN.

The issue that can generate astrobioethics can give us a vision of a greater theoretical reach that can settle down the astrobiological exploration adventure on a better moral ground.

An interesting point to outline about this workshop is that it mentions that both terrestrial and extraterrestrial life have an instrumental and intrinsic value, in addition to having a special ethical status (Rummel *et al.* 2012, p. 1020). Of course, within the astrobioethical problem it is possible to ask what is meant by life. Since according to the concept that is handled, that will be the one that allows us to identify it in another non-terrestrial environment, that is to say, depending on the interpretation of Life, our ability to leave the bio-geo-centric framework may vary. In short, and in accordance with the results of this panel workshop, there is still a need for greater discussion regarding ethics in this subject (Rummel *et al.* 2012), and that is a relevant reason to consider astrobioethics as a new discipline of study, due to the particularity of the problems that it presents and for its inter-transdisciplinary nature.

Human Beings as Guardians of Life in the Universe

Another of the central aspects that should be addressed in astrobioethics is the one concerning the consideration of human beings as guardians of life in the Universe. This idea is referred by the NASA Astrobiology Strategy's index (Hays 2015), when the question 'Do humans have non-Terran ethical obligations?' is pointed out as one of the keys of ethics for astrobiology (Hays 2015, p. 157). The basis for this non-terrestrial ethics can be derived from the same principles from which UNESCO's Earth Charter is derived (The Earth Charter Initiative 2000) There, planet Earth is considered as our only home, and humans are the guardians of the Earth and of what inhabits it. In this sense, it shares the code of ethics of Geoethics (González & Martínez-Frías 2011, p. 13).

Astrobioethics as a branch of astrobiology and as a relative of Geoethics, allows us to think of our planet as our only home in the cosmos and respect it. Life on Earth is a unique event, we are fragile in front of the infinite Universe and that should give us a sense of humility and solidarity with each other. We recently realized this when the first photographs from the Earth were taken by Apollo 8 and then with a full image of our planet taken by Apollo 17 (Odum & Barrett 2005). Perhaps what happens to astrobioethics is similar to what happened to the ecology field when the public began to taking it seriously after those images in the 1970s were published (Odum & Barrett 2005), maybe astrobioethics will draw public attention as the day we try to put humans on Mars approaches.

Here, a couple of problems may arise. The first is that, if we are the guardians of life in the Universe then it is our right to propagate it. Second, if we do propagate it, we would be putting at risk other forms of life that we do not know, although this will be inevitable because sooner or later we will have to move to other celestial objects that can be inhabited. For this, the principle of precaution could be suggested, exhausting all the possibilities of finding life, for example, before sending people to Mars. A window of time may be proposed in order to be sure that there is nothing there, and if we are not totally sure, we can at least propose planetary parks where we might suspect that there may be life or remains of it.

This window of time can be of 50 or 100 years, depending on the political pressure, or on the consensus reached. Maybe in the near future there will be a space race of private investment that might accelerate this scenario. Whatever the case, the problems of astrobioethics will remain present. Is a window of 50 to 100 years enough? To what extent can we be really sure that the place we choose to land has no trace or evidence of Martian life? Uncertainty will always be present, but at least having this window of time will provide us with a psychological rest and will decrease the chances of killing (or modifying) the possible life or biosignatures that might exist there.

This side of astrobioethics can be considered as the aspect that covers the most important part of the moral considerations, since the first one has covered the juridical aspect. Legal and ethical issues do not necessarily go hand in hand. For example, a person may win a suit for alimony, but he might not be a morally correct person. In this way, despite having a legal framework, new conceptual problems will always arise in the ethical field, not because there are no laws, but because of the interpretation and the constant changes that can occur in the definition of the law.

If we imagine that a person or a group of people are sent to Mars knowing that they will never return, would that count as a form of sacrifice? We could have two interpretations to get an idea. If we are Kantians we say that the human being has a value by itself for being rational, and therefore it is not moral to use him as a means to achieve certain ends, because we would be treating him as an object.

On the other hand, if we are utilitarian we could argue that it is morally good to do so because it would be done for the sake of humanity as a whole, and the result of their journey and stay will help future generations to survive, once is needed. There is no single answer to this problem because the point of the astrobioethics is to reach a consensus. The philosophical heritage of astrobioethics, therefore, allows us to conceptualize new problems and not let ourselves be led by univocal solutions that cannot exist. We can always discuss our arguments and that is very important because the transdisciplinary exercise inherited from astrobiology requires it to be that way.

Another mental exercise within astrobioethics that sooner or later will be a topic of debate is that if a human being is born on Mars, should he still be considered human? Biologically he is, but as the time passes and he has himself offsprings, the effects of the atmosphere and the Martian conditions would probably change his constitution to the point where he can no longer be

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considered totally human as it were if he were born on the Earth. In that sense, under what laws would someone born on Mars be governed by? Although these are still under a highly speculative terrain, they are problems that can be discussed as we advance in the astrobiological exploration. We must consider also that actually a human cannot survive on Mars if not recreating the conditions existing at the surface of Mars; this is a big difference from past referents because unlike the Spanish/British/French/Dutch colonies in America and elsewhere, with Mars we have the issue of terraforming.

Social Responsibility in the Informative Aspect

This third aspect of astrobioethics agrees with the fourth principle of astrobiology proposed by NASA in its Astrobiology Roadmap, which states that the astrobiology generates interest and has great educational and social potential (Des Marais *et al.* 2008; Hays 2015). This is consistent with the building of a peaceful society in the Outer Space Treaty (UN 2002) and The Earth Charter (The Earth Charter Initiative 2000). Astrobiology has a great pedagogical potential, as it teaches us to relate disciplines, fields of knowledge, which must be applied according to the context and the problems to be solved. It allows us to make critical sense in evaluating the best disciplinary available tools.

It is a way to educate the population because it asks the great question of whether we are alone or not in the Universe. It is a great opportunity to confront the pseudoscience that has gained ground in places where the scientist has turned his back on society, refusing to talk about topics of life in the Universe in contexts where people ask for more information. It is time to realize that we cannot turn our backs on the population just because we think about our own status. There are places of pseudoscientific debate where the academic themselves must penetrate and make their knowledge known, since that is where it is most needed. Usually, people attending scientific outreach conferences are already prepared to receive this kind of knowledge, but there is a great vacuum to fill in areas where scientific dissemination is nil and rather pseudoscience prevails.

To achieve a greater outreach in the society, astrobioethics emphasizes the importance of scientific dissemination, because it is there where we have the opportunity to make contact with the population. In order to achieve this goal, it is essential for universities to promote courses or workshops on scientific dissemination and scientific leadership, as not only they need scientists who know how to communicate, but also how to inspire and lead. This in turn will promote communication between disciplines, since the first step for a transdisciplinary activity is that the language of dissemination can be used, allowing more complex levels of communicability within sciences, such as diffusion (to a moderately specialized public) and dissemination (to a specialized public).

In the social aspect of astrobioethics, it should also be noted that science is part of culture and, as such, is subject to changes according to the needs of the population. That is, science reflects in one form or another, the state of the society. This became more evident during the Cold War, when the competition between the Soviet Union and the United States for the world hegemony led to invest in an aggressive space race, thus achieving a strong growth in technology and further on science. Astrobioethics will face problems that will not only be in the realm of natural sciences, but also of the social sciences, and why not, even in political sciences. The discourse used by politicians should not intimidate the scientist prepared to deal with the social aspect of science.

Dick (2012) also noted the relevance that astrobiology has for the society and which may well be framed within astrobioethics, because of the impact that might have on society the discovery of a new form of life that is not terrestrial. How will society react to such discoveries? Would religion change? Will it have an effect on nations and politics? These questions that may be a mental experiment are already in fact subjects that can now be debated, because if life is discovered on Mars that will have tremendous cultural consequences. Some other cultural practices such as religion are simply going to adapt to new discoveries (Chon 2016), just as the Copernican revolution took place where Earth was no longer the centre of the Universe.

Of course, the possibility of finding life on Mars, or in Enceladus or in Europa, is real and has to do, for what we know at the present time, essentially with microbial life, not intelligent and cognitive life. However, the mere fact of finding microbial life in any of these celestial objects already implies a change in the worldview of humanity, one where, finally, with empirical evidence, it has the certainty that we have never been alone in the Universe; and that what Metrodorus of Chios said in the IV BC is true:. 'It would be strange if a single ear of corn grew in a large plain, although only one habitable world in the infinite'.

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