Chapter 9

A Philosophical Outlook on Potential Conflicts Between Planetary Protection, Astrobiology and Commercial Use of Space

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Introduction

The aim of this chapter is to use philosophy and, in particular ethical theory, to identify and explore some potential conflicts between planetary protection, astrobiology and commercial use of space.

According to NASA's astrobiology roadmap, astrobiology is a research field that addresses the following questions: 'How does life begin and evolve, does life exist elsewhere in the universe, and what is the future of life on Earth and beyond?' (Des Marais et al. 2003; 2008). I will, however, concentrate on the most well-known and most curious part, namely the search for life outside our planet. This might sound a lot like science fiction, and the truth is of course, that we have still not found any extra-terrestrial life (at least, not at the time of writing). The search for extraterrestrial life is not science fiction, however. It is, in fact, a very serious scientific endeavour that the scientific community judge to have a high probability of success in the not too distant future. The fact that we have still to find extraterrestrial life also makes it an unusually suitable subject for ethical discussions. Contrary to what is typically the case on our own Earth, the fact that we have not yet found any extraterrestrial life gives ethics a chance to influence our decisions from the beginning, instead of just pointing out where we went wrong *ex-post-facto*.

Commercial use of space might seem just as much like science fiction as the discovery of extraterrestrial life, but the fact is, it is already happening (see Beavin 2008; Beery 2012; Giacalone 2008; Hubbard et al. 2013; Lewicki et al. 2013; Peeters 2003), and the road is being paved for a much more intensified commercial use of space. This development is interesting from many different perspectives, and it evokes many complex ethical questions.

Planetary protection, the way the term is used today within the astrobiology community, is essentially a technical term for measures aimed at avoiding biological contamination, either of extraterrestrial environments (forward contamination) or of our own Earth (back contamination) resulting from human space activities. The legal basis for planetary protection can be found in the *Outer Space Treaty* from 1967, stating in Article IX that 'Parties to the Treaty shall pursue studies of outer space, including the Moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose' (UN General Assembly 1966).

As is usually the case with international treaties, it states over-arching principles rather than precise goals or instructions. We can therefore not conclude exactly what 'harmful contamination' means, or what needs to be done to avoid it, based solely on the treaty. The responsibility for setting up more detailed guidelines regarding planetary protection has fallen on the Committee for Space Research (COSPAR), under the International Council for Science (ICSU). The first Planetary Protection Policy developed by COSPAR was published in 1964. The latest planetary protection policy, put together by COSPAR's Panel for Planetary Protection (PPP), was published in 2015 (Kminek and Rummel 2015). It specifies which degree of protection is needed for different types of activities (probe, lander, flyby, orbit) on different bodies (planets, moons, asteroids) depending on their estimated interest to astrobiology. Mars and Europa are particularly interesting to astrobiology, and there are therefore special requirements for flyby, orbiting and landing on, as well as sample return missions from these bodies. There are also special requirements for certain regions, so-called 'Special Regions' on Mars, where it is thought more likely that earth organisms could survive (Kminek and Rummel 2015).

Strictly speaking, the policies are recommendations and not legally binding (though the Outer Space Treaty brings in those countries that have ratified the treaty). In practice, the COSPAR guidelines are respected by the space agencies of the major space-faring nations, though they themselves typically specify the COSPAR recommendations even further to fit individual missions (see, for instance, *https://planetaryprotection.nasa.gov/overview,* accessed 9/2/2017).

When put in a wider context, it includes several intricate philosophical conundrums. In fact, both forward and back contamination have interesting ethical implications, but since my focus here is on extraterrestrial life, I will only discuss forward contamination in this chapter.

Planetary protection, astrobiology and commercial activities in space are three human endeavours that are in some ways very different, but that also have two major aspects in common: They are all related to human activities in space, and they all have the potential to affect living organisms in ways that need ethical deliberation. When these three activities are combined, we will get a whole set of new, and, from a philosophical point of view, exciting questions. The main aim of this chapter is to point at, explore and, to some extent, suggest ways to handle some of these questions.

Astrobiology and Planetary Protection

Planetary protection is extremely important for astrobiology. When looking for extraterrestrial life, it is obviously crucial to avoid false positives due to contamination by earth life. If and when we ever find extraterrestrial life, it is also very important to be able to study it in its pristine form without contamination from earth life, and of course, most important of all, that the indigenous life is not driven to extinction by invasive earth organisms before it is even discovered. When sending unmanned as well as manned missions to other worlds, it is therefore vital to avoid contamination of that world. Considering how important planetary protection is to astrobiological research, it is easy to believe that is no conflict between the two. This is not completely true, however. Even though efforts to avoid contamination are quite sophisticated and considerable work is put into the process, we also know that complete sterilization of humans and machines is impossible (see Kim et al. 2013; La Duc et al. 2003; 2007; Moissl et al. 2008; Mahnert et al. 2015; Newcombe et al. 2005; Schuerger and Nicholson 2016; Stieglmeier et al. 2009; Tepfer and Leach 2017; Dartnell et al. 2010 for some examples of the challenges involved). We can obviously never totally sterilize humans. If we did, the humans would die too. We can go somewhat further with machines but essentially, the same is true for them. The electronics in a rover is more sensitive than at least some earth microbes. We also know now that what kills some bacteria allows others to flourish. Interestingly, our efforts to sterilize exert a selective pressure in favour of strands that are resistant to these efforts. Planetary protection is thus something that comes in degrees and it will always be possible to do more or less than we already do. This means that we must make decisions about exactly how far we want to go. It would be easy to say that the more the better, but the only absolutely safe way would be not to send anything to any other world. As long as we want to go on exploring, in space as well as on Earth, we have to find a compromise between the importance of discovery and the risks we impose on the study objects in the process.

Another aspect to consider is that planetary protection, like everything else, comes at a cost in terms of time, work and money that could be used on other things, also worthwhile. The experience from the Viking landers, that were the most thoroughly decontaminated landers so far, confirms that decontamination can be prohibitively expensive (Newcombe et al. 2005). Schon (2009) opposes a higher standard of sterilization because it would mean higher costs, and some astrobiology researchers complain that even today's standards are too high, or as one researcher put it: 'Over the top' (private communication).

These facts taken together show that protecting the life we are looking for and want to study is important, and so is shielding experiments from false positives. It also shows, however, that planetary protection comes with certain costs and that the search in itself also poses a very real danger to the extraterrestrial life we are looking for. If we still want to be able to look for and study extraterrestrial life, we need to find a balance between our efforts to find and study it and our efforts to protect it.

COSPAR has provided an explicit answer as to where that balance can be struck, namely at the degree of planetary protection needed to give science enough time to find and study possible life (see, for instance, Sagan and Coleman 1965; Kminek and Rummel 2015). They have thus chosen a degree of planetary protection that has a strictly defined purpose with clear limitations in both degree and time.

The aim of planetary protection, as it is formulated and applied by COSPAR, is sometimes stated as being a matter of 'protecting the science' rather than protecting extraterrestrial life as such. A more philosophically stringent way of putting it would be to say that extraterrestrial life is protected only because of its epistemic instrumental value. Here, 'epistemic value' refers to value that has to do with knowledge or the production of knowledge, while 'instrumental value' refers to the value something has because of its ability to promote something else that has value (in this case, knowledge). Taken together, referring to the value of extraterrestrial life as epistemic instrumental value, means that extraterrestrial life has value as a source of knowledge, that is, as objects for study.

The question we should ask, however, is: Could it be possible that extraterrestrial life in addition to its value as study objects, also have other values? If it is, then we also need to ask: What practical consequences does that have for the relation between astrobiology and planetary protection?

It is conceivable that extraterrestrial life can have other values, but that these values will be sufficiently similar to the epistemic values, or be weaker or less vulnerable than the epistemic values, and thus confirm that the present guidelines for planetary protection are sufficient to also protect these values. Another possibility is that they have values that are even more important or more vulnerable, and that we will therefore need even stricter guidelines to achieve an even lower probability of contamination, compared with today. The most extreme scenario will, of course, be that we have to set the maximum acceptable probability of contamination so low that sending spacecraft from Earth to a potentially inhabited world will in practice (and maybe even in principle) be ruled out. This would be a very sad conclusion and it is not something I see as very plausible, but it at least needs to be discussed. Another and much more plausible possibility is that we will have to abolish time limits. If extraterrestrial life has value in any other way than as study objects, it is very hard to justify why they should only be protected for the time it takes to study them. Yet another possibility is that there will be restrictions on what we are allowed to do in order to find extraterrestrial life, and what we are allowed to do to them when we find them. Will we, for instance, be allowed to use destructive detection methods as was the case with the Viking experiments? (see Horowitz et al. 1972; Hubbard 1976; Klein 1978). Will we be allowed to bring them back to Earth to study them, and will we be allowed to dissect or perform other intrusive experiments on them?

What is important to remember is that these questions are not science questions. They are value questions. They cannot be settled by science alone, and this is where philosophy enters the picture.

Let us summarize our options:

1. Extraterrestrial life has no other value than their epistemic value. In this case, all we have to do is to figure out the exact level of protection needed to protect their value as study objects as long as is needed to study them thoroughly, and then figure out how to achieve that level of protection. These tasks are by no means easy but at least they are scientific and technological/methodological tasks. If this is our conclusion, there will be no more need for philosophy.
2. Extraterrestrial life has at least one other kind of value but it is a kind of value that does not warrant any extra protection in addition to the planetary protection guidelines. The practical implications of this conclusion are the same as for 1.
3. Extraterrestrial life has at least one other kind of value that is sufficiently strong to warrant protection but it is a kind of value that does not warrant any extra protection in addition to the planetary protection guidelines. It does, however, warrant limitations as to what we are allowed to do to detect it, study it or utilize it in some other way. In this case, the present level of planetary protection is probably sufficient, but other restrictions need to be set regarding detection methods and what we will be allowed to do to this life once we find it. The latter concerns will not be of direct concern for planetary protection the way it is presently defined, but it has to be handled some way. One way of handling it would be to widen the present interpretation of the term 'planetary protection', which would call for a reinterpretation of the Outer Space Treaty. Another way would be to set up an additional treaty to handle these questions. Both these options would require a body that can handle the details in a similar way to what COSPAR is doing today. This could be done by extending the mandate of COSPAR to also deal with these issues, or by instantiating a completely new organization for this purpose, or to give this mandate to some other existing organization.
4. Extraterrestrial life has also at least one other kind of value that is strong enough (it could be stronger, weaker or equal to its value as study objects) to warrant protection but that has no end point in time. In this case, we need to abolish the time limit for planetary protection, which will, in turn, affect how we calculate the maximum acceptable probability of contamination for individual missions.
5. Extraterrestrial life has at least one other value that is strong enough or a number of other values that together are strong enough (if one believes in the accumulation of values) to make it trump all other values. In this case, it will not be a matter of finding a balance. We simply have to stop doing anything that could interfere with this life.

Deciding which one of these options is the correct one is too big a question to be answered in this chapter. Since it is a value question, it is not subject to the same process of shrinking the room for interpretations that empirical findings provide

for scientific theories. We will thus probably never reach a situation where we can all agree on one particular option. This does not mean the discussion is meaningless, however. On the contrary, an ongoing discussion that can shape the public policy regarding where to strike the balance between exploration and planetary protection, and between these two and a wider societal and ethical perspective, will be of crucial importance in order to make the policy decisions as ethically justifiable as possible. Later in this chapter, we will discuss some alternative ways in which extraterrestrial life can have value and what implications that may have. Before we get to that, it is time to introduce another complication, however.

Adding Commercial Space Use

In the previous section, we found that the relation between astrobiology and planetary protection is more complicated than one might expect at first sight. In this section, we will show how things become even more complicated when we add commercial space use to the formula.

The question of legal rights for commercial initiatives in space is very important. Anyone who invests major sums of money in an activity wants to make sure that they will not lose their investments because it turns out afterwards that they did not have the right to the resources they extract. It is also important to have laws in place that regulate the relations between different companies from different countries, bound by different laws in their home countries, but trying to coexist in space.

There are also questions of coexisting with other players with other agendas, such as the scientific community. It can be expected that space research and commercial space projects will prove to be very useful for each other. Space research is necessary for commercial companies to make sound business decisions about their activities in space. Commercial space companies will also be, and to some extent already are, useful for science. They are, for example, already providing launch capacities. This service will probably be the most valuable commercial contribution to space science, at least in the short term. Many hope that private launch solutions will be more cost efficient than those provided by major national and international space agencies such as NASA, ESA and Roscosmos. In the future, space mining may also provide access to resources, such as fuel and construction materials in space, which will make it possible for the scientific community to reach further with more ease and less money, and to build and operate observatories in space, etc.

In addition to the many opportunities for cooperation that can be expected, there will, however, also be points of conflict. Will planetary protection be such a point of conflict? There are not yet any commercial activities on Mars or any other extraterrestrial body, and the most immediate plans for space tourism are only about sending people into Low Earth Orbit, or even just about making a short 'jump' into space to let the passengers experience a short moment of

weightlessness. Likewise, the immediate plans when it comes to space mining are about asteroids, which are considered by COSPAR to be among the least probable places to find life in our solar system (Kminek and Rummel 2015). Even so, at least one company has foreseen that their operations might be controversial. They have therefore produced a web page entitled 'Asteroids are cold, dead worlds', seemingly aimed at setting the reader to rest that asteroid mining really does not have any objectionable environmental impact on the target bodies, and also that mining and using resources from asteroids will even be a good thing for the earth environment (https://deepspaceindustries.com/asteroids-are-cold-dead-worlds/ accessed 03/01/2017).

It is not a very controversial assumption, however, that when the time comes to exploit the resources on a potentially inhabited world, or to establish it as a tourist destination, we will see conflicts between those who think that we have looked for life long enough on the world in question and that it is now time to give the green light for development, and those who think that there is still a chance there might be life that we should not endanger.

It all depends on the values at stake, of course. If we assume that extraterrestrial life only has value as a study object, it might be very difficult to resist exploitation even if it potentially puts indigenous life at risk. Economic value is privileged by our society, and when the value of knowledge as such is set against economic value, the former usually loses.

An alternative possibility is that extraterrestrial life, in addition to its value as a study object, also has economic value. Just like with the value as a study object, this is also a form of instrumental value: Something has economic value because it can generate money. Can extraterrestrial life have instrumental value in this way, and what does it mean for the relations between astrobiology, commercial interests and planetary protection if it does?

Cockell (2011a) mentions bioengineering as an example. He distinguishes between the economic value of extraterrestrial life that is related to us (spread through the solar system according to the so-called panspermia theory) compared to if it is not related to us. This distinction makes good sense. It is easy to imagine that a microbe that is genetically well adapted to life on another world might contain adaptations that we will want to insert into earth bacteria and use for different purposes. In such cases, it clearly makes things easier if they are genetically related. If they are, we will be able to transfer the properties in question to earth life by transferring the relevant genes from extraterrestrial microbes to earth microbes. Interesting properties could, for instance, be the ability to survive high doses of radiation, which could be useful if we, for example, want to engineer microbes to do work inside a nuclear reactor or disaster area, or aboard a spaceship travelling between Earth and Mars. An ability to extract energy from the Sun in a very efficient way would be another example of a useful property that might be found in microbial life on worlds further from the Sun. In addition, it is also easy to imagine that life that is already adapted to life on another world but is also compatible with earth life will be useful if we want to transfer traits from earth microbes to extraterrestrial microbes in order to tailor

make microbes that future space-dwellers can use to produce anything from food to fuel in their new habitat.

When it comes to extraterrestrial life that is not genetically compatible with earth life, it would be more difficult to transfer properties between them and earth life in either direction, even if not in principle impossible (maybe we will be able to extract the relevant information from their equivalent to a genome and translate it into the language of DNA). Even if extraterrestrial life cannot be genetically mixed with earth life, they could be used for bioengineering, however, though without involving earth life in the process.

If we find extraterrestrial life that has value as a resource for bioengineering, it could mean that the aims of science and business actually converge when it comes to planetary protection. In order to use extraterrestrial microbes for engineering, they will need to be protected so they do not go extinct, but they will also need to be found and studied. This indicates that the degree of protection suitable for extraterrestrial life as resources for bioengineering could be very similar to the degree of protection suitable for extraterrestrial life in their role as study objects. There is one difference, however, namely that the limit for how long they need protection may not be the same. If we want to use them for bioengineering, they need to be protected beyond the time it takes to study them. On the other hand, the time it takes to study them enough to map their economically useful properties may be shorter than the time it takes to study them thoroughly from a scientific perspective. The value of extraterrestrial life as study objects and as resources for bioengineering may thus make different demands on the time-span during which they have to be protected, and therefore, also on the degree of protection. Which type of value that will be more demanding is not possible to say before we have actually found them.

Another way in which extraterrestrial life can have economic value is in the form of entertainment. This too demands some degree of planetary protection, though the demands will be different compared to the demands from bioengineering. We can easily imagine that the interest in seeing extraterrestrial life with one's own eyes will be immense. This value can be exploited in two different ways, either by bringing people to their world, or by bringing the extraterrestrials to us. Both these alternatives will put extra pressure on planetary protection. We have mentioned that it is impossible to completely sterilize humans. This means that bringing human tourists to see extraterrestrial life in situ carries a substantial probability of being destructive. If they are compatible with earth life, it might also imply a risk for the tourists. Bringing the extraterrestrials to Earth will for obvious reasons also imply risks, in this case for us and other earth life. Sterilization will not be an option in this case (we do not want to kill the life we have brought such a long way to see).

All in all, we can conclude that if we look at the question of planetary protection from the perspective of science or from the perspective of business, and even when we consider different business perspectives, the result may differ considerably. Considering the expected increase in commercial space use, this obviously complicates things for science as well as for planetary protection.

Does Extra-terrestrial Life have Instrumental Value Other than Economic and Epistemic Value?

Are there any other ways in which extraterrestrial life can have instrumental value than the two forms of value discussed above? The answer seems to largely depend on which properties they turn out to have. Different properties mean different uses and thus different bases for instrumental value. We can be sure that they will have epistemic value, and it seems plausible that they will also have economic value in some form, if not for bioengineering, at least as entertainment. Saying anything else about their potential instrumental value before we have found them, and thus before we know their properties in any detail, is difficult. What we can say, is that whatever kind and degree of instrumental value they have, that value has to compete with other values. If we find other resources that can be extracted from their world and they somehow will be in the way of that, it will be hard to fight for their protection, just as it has been and still is with life on our own planet. If we can establish that the extraterrestrial life forms also have non-instrumental value, it would definitely change the game. It might still not be enough to demand a higher degree of planetary protection or to say that there are certain things we will not be allowed to do to them, but it might, and therefore, I think it is our duty to investigate the possibility.

Does Extra-terrestrial Life Have Non-instrumental Value

Can we imagine extraterrestrial life having value beyond their instrumental value? This question often takes the form of a question whether extraterrestrial life has *intrinsic value* (see, for instance, Cockell 2011a, b; Cockell and Horneck 2006). Since different authors tend to use the term 'intrinsic value' in different ways, this way of formulating the question is hopelessly opaque, however. Attempts to untangle the different meanings of the term (O'Neil 1997; 1992; Persson 2008; Rabinowicz and Rønnow-Rasmussen 1999) have revealed at least four different meanings:

1. Value as an end in itself, independently of what other values it can promote (also known as 'end value', 'final value' or just 'non-instrumental value'),
2. value that is inherent in the phenomenon in question and thus independent of its relations to other phenomena (also known as 'inherent value' or 'non-relational value'),
3. value that is independent of whether it is valued by someone (also known as 'objective value'),
4. moral standing, which means that the phenomenon in question has interests of its own that need to be considered by anyone who has the ambition of acting morally.

Strictly speaking, the question of moral standing is not about the *value of* the phenomenon in question, but rather about whether things can have *value to it*.

For the purpose of this chapter, we only need to pursue two of the different meanings of 'intrinsic value', namely, the first ('end value'), and the last (that is, moral standing). We thus need to ask: Does extraterrestrial life have end value, and/or does it have moral standing?

Does Extraterrestrial Life Have End Value?

Before we start investigating whether extraterrestrial life can have end value we need to be aware that instrumental value and end value are not mutually exclusive. It is perfectly possible to have both. Something can have value as an end in itself, and also be a useful means to something else. A watch can, for instance, be very useful for keeping time but also be a precious heirloom. A trusty old car that has been with its owner through many adventures can be convenient for getting from A to B and thus have instrumental value, but when it is stolen, it can still evoke a feeling in the owner that she has lost something more dear to her than just a means of transportation. It can have end value to her in addition to its instrumental value. The fact that we have found several ways in which extraterrestrial life can have instrumental value does not therefore compel us to give either a positive or a negative answer to whether it has end value.

So, can extraterrestrial life have end value? The simple answer to this question is: Yes, anything can be valued as an end in itself by anyone! This is true. We might, however, also want to ask whether it is reasonable to value extraterrestrials as ends in themselves. The answer to that question is also yes, for several reasons. One reason is that life as such seems to be one of these things that most people value for its own sake independently of its instrumental use. A large part of the motivation behind the environmental movement can, for instance, be attributed to this intuition (Persson 2008). The fact that we talk about extraterrestrial life can add to this value, at least based on the huge interest among the general public for the question of whether extraterrestrial life exists, an interest that is supposedly not only based on the value of extraterrestrial life as a study object or other instrumental values it might bring. In addition, the circumstances during which we find extraterrestrial life, as well as what kind of life we find, might add to its end value. Being first seems to be a property that is a strong basis for end value for many people. The first extraterrestrial life we find will therefore surely have end value in its capacity of being the first discovered extraterrestrial life. Uniqueness is another property that is a basis for end value to many people (Persson 2017). As long as we only find one instance, it will therefore also have end value because it is unique. If we find extraterrestrial life on more than one world, it will not be unique in this way, but since life on one world will probably differ considerably from life on another world, it can be safely assumed that they will all have properties that make them unique in one way or another (Persson 2017). In fact, this is true even of the different forms of life we already know on our own planet today. All life on Earth is related but has evolved in many different

ways, resulting in an almost endless number of unique solutions. Considering the differences in physical conditions between different worlds, we have reason to believe that this will be the case to an even higher degree if we look at life on different worlds, and this as such seems like a good reason to attach end value to extraterrestrial life.

It can also be expected that the extent to which the life we find has properties that make it interesting or exciting will play a role. More complex life will probably be considered more valuable than less complex life independently of whether it makes the life in question more instrumentally useful or not. In the same way, life that expresses a more complex behaviour or is aesthetically more pleasing to us will probably be considered more valuable than life with a less complex behaviour or that is less aesthetically pleasing. Another property that, with a high degree of certainty, can be said to add end value to a life form, from our perspective, is its ability to communicate with us. The more we can interact with it, the more exciting will it be, which in turn will make us value it higher as an end in itself, no matter whether it makes it more or less useful to us.

To what degree a certain life form has end value thus depends on its particular properties, but we can also conclude that all extraterrestrial life will have some degree of end value based on the fact that it is life, and that it is extraterrestrial.

Does Extraterrestrial Life Have Moral Standing?

Having moral standing, or being a moral object as it is also called, is not the same as having end value. Strictly speaking, it is not about the value of the object at all. To say that you have moral standing means rather that things have (positive or negative) value to you, and that is something that has to be considered by others.

To answer the question of whether extraterrestrial life has moral standing, we need to consider two things: What kind of life are we talking about (which properties will it have), and what are the criteria for having moral standing (which properties are necessary for having moral standing)?

Obviously, we do not know what kind of life we will find, and a philosopher's job (in spite of popular belief) is not to speculate about what is at least in principle an empirical question, but rather to analyse and scrutinize the non-empirical questions, so let us keep an open mind regarding the question of what kind of life we might find, and consider what different theories about moral standing have to say about the moral standing of different kinds of life, but with the proviso that planetary protection is, given current technology, only applicable to activities in our own solar system, and that there seems to be a rather strong belief among astrobiologists that as long as we talk about our own solar system, we will probably not find anything very complex. I will, therefore, put extra focus on what the different theories about moral standing have to say about the simplest kinds of microbial life.

The question of what it takes to have moral standing is intensely discussed in environmental ethics on our own planet, and the answers are typically divided into the following categories:

1. Anthropocentrism – all and only humans have moral status (Carruthers 1994; Kant 1998; Smith 2009).
2. Biocentrism – all and only living beings have moral status (Schweitzer 1976; Goodpaster 1978; Cockell 2005; 2011a).
3. Sentientism – all and only sentient entities have moral status (see, for instance, Bernstein 1998; Clark 1977; de Grazia 1996; Helm 2002; Levine 1997; O'Neil 1997; Regan 1983; 2001; Singer 1993; 1995).
4. Ecocentrism – Species and biomes have moral standing in addition to living beings (see, for instance, Callicott 1980; 1985; 1987; 1992; 1999; Johnson 1991; 1992; Leopold 1970; Plumwood 1991; Rolston 1986; 1987; 1988; 1994; 1999).

Here I will briefly discuss what these theories imply for extraterrestrial life (for an extended discussion see Persson 2012).

Anthropocentrism

If we want to apply this theory to the question of whether extraterrestrial life has moral standing, we need to distinguish both between different kinds of extraterrestrial life and between different versions of the theory. If we adhere to the simplest version of the theory, namely that the criterion for having moral standing is simply to belong to the species *Homo sapiens*, then we can be quite sure that no extraterrestrial life will ever have moral standing. Even in the seemingly unlikely event that we find extraterrestrial life forms that look just like us and share most of our features, they will not be the same species as we, and thus not human in this very strict sense.

The basis for anthropocentrism is usually not species membership as such, however. Instead, the focus is typically on some property that, on this planet, is supposed to only be possessed by humans. Examples of such properties could be intelligence or language skills on a level that is beyond what is found among other species on our planet.

Not even the most optimistic astrobiologists believe that we will find extraterrestrial life with any humanlike properties in our solar system. This means that if we accept anthropocentrism, we do not have to worry about considering the moral status of extraterrestrial life in connection with planetary protection, as long as we, as is the case here, only talk about forward contamination, and as long as we stay within our solar system.[1]

1. See Lehmann Imfeld, this volume, for a discussion of the ethical implications of anthropocentrism in the terraforming of Mars.

If we extend our discussion outside the solar system, we do not know what we might find and it is at least not impossible that we will find life forms that share some of our properties. Applying anthropocentrism on our relations with them, the result may be mostly detrimental to us, however. If we base moral status on the property of being human in a strictly biological sense, how can we argue against any possible alien invaders, who by the same logic claim that they do not have any moral duties to consider our interests since we do not belong to their species?

If we instead use, for instance, intelligence as the basis for moral standing and they are much more intelligent than we are, maybe so much more that our level of intelligence, in their eyes, is not significantly different from the intelligence level among the earth animals that we use for our own purposes today, what then? Should we just succumb to our new role as slaves or food for our new overlords or do we have any moral basis from which we can argue that their treatment of us is wrong? It might be hard to do that and at the same time maintain that we have the right to treat other, from our perspective, lower species, the way we do today.

Biocentrism

At first sight, it may seem as if biocentrism would demand a very high standard of planetary protection, including sterilization of all equipment aimed at, or in risk of landing at potentially inhabited worlds. If we think one step further, however, we realize that what is sterilization other than the systematic mass killing of earth microbes? It would, from a biocentric point of view, be very hard to motivate planetary protection measures that imply the killing of countless numbers of actual life microbes in order to protect merely possible extraterrestrial life based on the moral standing of all life. It thus seems that the conclusion has to be that we have to completely abstain from a central component of planetary protection, that is, sterilization. Instead, we have to decide whether to go without any sterilization measures or not to go there at all. This decision presumably has to be based on how probable we think it is that the target world is inhabited and how probable we think it is that it is inhabitable for earth microbes.

The latter alternative (not going at all), is perhaps too restrictive even from a biocentric perspective, however. Granting moral standing for extraterrestrial life does not necessarily mean that we are not allowed to do anything on an inhabited planet. How prohibitive an ethical theory is depends on how we answer all the ethical questions, not just how we answer the question of what it takes to have moral standing. If we, for instance, subscribe to a utilitarian view of ethics, the interests of all moral objects have to be considered and weighed into the equation. The outcome depends on the whole equation containing all affected interests according to their relative strength.

In either case, if we decide that it is acceptable to go to their world, we will have certain obligations to protect the extraterrestrials. Even if this will not take the form of sterilization of spacecraft, it can take other forms that will affect the

study of these life forms. It may, for instance, imply that we have to abstain from destructive experiments (that is, experiments in which the study objects are killed or injured) and from taking them from their own environment and bring them back to Earth for closer examination.

Sentientism

As long as we stay within our solar system, sentientism probably has the same immediate consequence for planetary protection as anthropocentrism, namely, that the life we expect that we might find in will not have any moral standing. There is, of course, some difference in probability. We do not know what hides under the ice of Europa, for instance. Even though the probability that it will be sentient is very low, it is not as low as the extremely low probability that it is human-like.

If we look beyond our present capabilities and think about the implications of sentientism when we achieve the technological ability to detect biosignatures outside our solar system, the most obvious challenge will be to distinguish between sentient but not intelligent life on one hand, and non-sentient life on the other. This is in some cases a difficult challenge even on our own planet. When we encounter life that might be radically different from life as we know it and has evolved under radically different circumstances, how do we then decide whether it is sentient? This is a question that we cannot yet answer, though that does not of course mean that we should abstain from using sentience as the decisive criterion for moral standing if this is the criterion that makes the most sense from an ethical perspective (which seems like a very reasonable assumption). It means, however, that we have to be extremely careful when the time comes to make a decision about whether a particular extraterrestrial is sentient or not.

Ecocentrism

If we accept ecocentrism, what implications would it have for planetary protection? One implication that is potentially very important, is that we not only will have to consider any individuals that we find, but also should avoid altering competitive relationships between species, or otherwise interfere in their relationships. This means, for instance, that not drastically changing the environment on their world.

On the other hand, killing some instances of individual extraterrestrial life would not be a big problem for the ecocentrist as long we do not threaten the whole species or the environment on the planet. This is potentially very important for the relationship between planetary protection and astrobiology. A theory that allows you to kill off a few, or a few hundred thousand individuals, as long as you do not threaten the species or the function of ecosystems, seems perfect for justifying both decontamination, where uncountable numbers of presumably very common earth microbes are killed off, and research that includes the killing of a number of individual extraterrestrial microbes in the process. On the other hand, though both anthropocentrism and sentientism deny moral status to individual microbes and for species, they accept that species can have value

(though not moral standing). Both these theories would thus provide exactly the same allowances as ecocentrism as long as we talk about microbial life. That is, from an anthropocentric or sentientistic point of view, it would also be okay to kill individual microbes as long as we do not threaten the species, given that the species have the kind of instrumental or non-instrumental value discussed above.

As long as we talk about microbial life and are only concerned about forward contamination, anthropocentrism and sentientism thus have the same practical implications as ecocentrism. If we find sentient or even intelligent life, on the other hand, the practical implications would differ considerably. In these cases, sentientism and anthropocentrism would set restrictions for what we are allowed to do with the individual organisms that ecocentrism would not. Ecocentrism does accept some level of moral status for sentient non-human individuals but it is much lower than the moral status of the species. The status of human or human-like life according to ecocentrism differs between different versions of the theory. According to some versions of ecocentrism (Rolston 1986; 1987; 1988; 1994; 1999), human individual life has a special status that puts it above other individuals and gives us some unique rights in relation to other species and ecosystems. Exactly which implications this has when we talk about human interest in exploration as well as in commercial activities is not really worked out by its proponents, though a fair guess would be that we would have relatively generous rights to explore and exploit individual extraterrestrial life as long as it does not threaten entire species or their environments.

According to another version of ecocentrism called *land ethics*, extraterrestrial life is explicitly excluded from the realm of moral objects (Callicott 1992). If we find life on another planet, we will for the first time have to deal with life that we are not related to, even distantly (provided of course that life has not been transferred between Earth and this other world in either direction). This means in turn that according to land ethics, extraterrestrial life cannot be included in our moral circle.

A general point to consider when discussing ecocentrism in relation to space exploration and exploitation is that ecocentrists usually do not show much concern for non-biological systems, which means that a world populated by intelligent robots will not have any moral standing according to this theory, even if they are conscious and/or intelligent. A maybe more immediate concern is that it is also unclear what happens to the moral standing of an extraterrestrial organism that is taken from its natural habitat and moved to Earth. When that happens, the organism will no longer fulfil its role in the species and ecosystem to which it originally belonged. Advocates of ecocentrism tend to consider domesticated animals and animals in zoos more as artefacts than as 'real' animals (Johnson 1991; Rolston 1988; 1994). It is possible that extraterrestrial life brought back to Earth will be considered in the same way and thus lose most of their moral status.

Summary and Conclusions

The relation between astrobiology, commercial space activities and planetary protection evokes a number of philosophical questions, not least value questions.

Value questions cannot be handled by science alone but they are, nonetheless, of utmost importance to science as well as for commercial space initiatives. In this chapter, I have identified and tried to throw some philosophical light on some of these questions.

The most basic value question in the intersection of astrobiology, commercial space activity and planetary protection is, of course, which values are at stake? It turns out that the value that solely motivates planetary protection is the value of extraterrestrial life as study objects, that is, the instrumental epistemic value of extraterrestrial life. It was also found, however, that this is not the only possible value at stake. For the commercial actors, the economic value of extraterrestrial life is probably of greater importance, which evokes another value question, namely, how the epistemic and economic values of extraterrestrial life relate to each other. It was found that in order to utilize extraterrestrial life for economic purposes, it has to be studied, so in that respect, the two values seem to be compatible. Extracting the economic value of extraterrestrial life can, on the other hand, interfere with the study of them, while the assumption that the study has an end point in time might mean that the economic value of extraterrestrial life calls for continued protection beyond the time needed to study it. Another point of conflict that is potentially more serious is that other things such as non-living resources may have a higher economic value than the extraterrestrial organisms. This can be expected to lead to conflicts over how long the search for, and subsequent study of extraterrestrial life, with accompanying high standards for planetary protection should be allowed to go on.

It is also plausible that extra-terrestrial life has other forms of value, instrumental value as well as end value. Exactly which values and how valuable will depend on the specific properties of the extraterrestrial life. All extraterrestrial life will share a minimum end value, supervening on it being alive and extraterrestrial, which includes an aspect of uniqueness. This, in turn, should be enough to motivate abolishing the time limit on planetary protection set by its value as study objects.

Another important question that has to be looked into is whether extraterrestrial life, in addition to any value it might have, also has moral standing. There are different theories about what it takes to have moral standing, which means the answer to this question depends on a combination of what kind of life we find and which theory we use.

How should we handle the conclusion that it is not just possible, but very reasonable to assign other values to extraterrestrial life, including economic value and other instrumental values, as well as end value, in addition to its epistemic value?

One way forward would be to widen the basis of planetary protection to also include these other values. A problem in connection with this suggestion is that planetary protection, the way it is done today, is based on a well-established international treaty, the so-called Outer Space Treaty. This treaty is the basis for national legislation regarding not just planetary protection, but also many other space-related questions (UN General Assembly 1966). Making changes in the value basis behind planetary protection might violate this treaty and

subsequently national and international legislation. An alternative way of handling the value issues identified in this chapter would be to complement the Outer Space Treaty with another treaty – an interplanetary environmental protection treaty.

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