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Accounting for non-humans in space exploration

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ABSTRACT

The human 'conquest' of outer space has relied upon an array of human-made objects and technologies and earth-born animals and plants that have been involved in the exploration of our planetary outside. These living and inanimate non-humans are important participants in space exploration, yet their extra-planetary presence is insufficiently articulated within the global registers of space law and policy. This paper explores the legal context and ethical issues surrounding their presence in space, suggesting that these nonhuman space explorers warrant attention and nuanced responses which would address their participation in the progression of our futures in space.

1. The silent cast of the space age

Space exploration propelled human presence and activities beyond the globe, allowing us to steadily extend our ways of life into an environment which is, in essence, a distinctly 'inhuman' space. Thousands of launches have sent various missions into the extraterrestrial unknowns, transforming outer space into what the United Nations' Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, also known as the Outer Space Treaty (OST), envisioned to be 'the province of all mankind' [1].[1] Designating outer space as a shared domain of the global commons, the OST placed astronauts as the pivotal point in the purview of its exploration, declaring them 'envoys of mankind in outer space' [1]. And yet, astronauts, and humans in general account for only a fraction of those who have left the planetary confines of the Earth; thus far, only about five hundred people have travelled into outer space [2] to partake in sub-orbital or orbital flights, lunar missions and research projects conducted at the space stations.[2] The majority of participants in the human exploration of space are non-humans – myriad earth born animals, plants and human-made objects, artefacts and technologies.[3] Over six thousand satellites, around a hundred space telescopes and several space stations have been placed into earth's orbital regions and various 'unmanned' orbiting, landing, roving and flyby probes are sent further still to explore a range of celestial bodies, phenomena and events. Numerous animate organisms are also dispatched to space on our behalf, from fruit flies, dogs and monkeys onboard early rockets to a menagerie including microbes, insects, amphibians, avians, rodents and various plants which are involved in experiments onboard the International Space Station (ISS). Although these animate and inanimate non-humans are playing a substantial role in the transformation of outer space into humankind's province, introducing and asserting the biological, social and technical registers of the terrestrial arena of life outside the boundaries of our own planet, their status and exploits are insufficiently articulated within the global legal and policy frameworks surrounding space exploration.[4]

This is not to say that non-human space explorers have been entirely

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[1] The Outer Space Treaty formulated a vision of peaceful, cooperative and responsible exploration and use of outer space that would benefit the whole of humanity. The legal tenants outlined in the main text of the Treaty were subsequently expanded through several agreements; these are the Agreement on the Rescue of Astronauts, Return of Astronauts and the Return of Objects Launched into Outer Space (Rescue Agreement, 1968), the Convention on International Liability for Damage Caused by Space Objects (Liability Convention, 1972), the Convention on Registration of Objects Launched into Outer Space (Registration Convention, 1978) and the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (Moon Agreement, 1984) [3–6].

[2] This select group is comprised of mainly astronauts and members of mission crews and also a number of civilians and industry representatives, including several commercial space tourists who visited the International Space Station (ISS) during the last couple of decades.

[3] The space age itself commences with non-humans – Sputnik's launch in October 1957 marked the official beginning of the space age, and several weeks later, a dog named Laika became the first living being from Earth to orbit the planet. While space technologies have been largely catalogued and most of their launches entered into the United Nations Register of Objects Launched into Outer Space, the number of living non-humans that have been sent to space is substantial, yet uncertain, as there are no equivalent data collection requirements and facilities.

[4] Contemporary intellectual thought on the 'non', 'post' and 'more-than human' ambits of the human condition emerges from the writings of Donna Haraway, Katherine Hayles, Gilles Deleuze, Bruno Latour, Rosi Braidotti and Sarah Whatmore and finds its expression within a range of inquiries into new materialism, animal studies, object-oriented philosophy and actor-network theory.

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overlooked - all 'things' sent in outer space are broadly classified as 'space objects' and a range of issues concerning their presence in space such as their status of property for which their owners are responsible and liable have been addressed in the OST system. While no particular kind of flora and fauna is directly mentioned, the Treaty's Article IX refers to organic forms of life in the context of potential harmful biological contamination that could occur in exchanges between the terrestrial and extraterrestrial environments [1]. Since OST statutes entered into force, a range of policies, protocols and guidelines that expound upon the particulars of non-humans' involvement in space exploration have been established by governments, space agencies, inter-agency organisations, international bodies and private space companies. NASA has developed its Principles for the Ethical Care and Use of Animals [7], and the Inter-Agency Space Debris Coordination Committee have been updating its Space Debris Mitigation Guidelines since 2007 [8] – indirectly affirming technological waste left by space exploration as a distinct kind of 'space object'. Yet, unlike astronauts who are considered the emissaries of humankind, those terrestrial beings and objects of non-human kind are not assigned such a representative status. Instead, they are contained in the global ambits of space law and policy as a side-issue of space exploration, conceived as its necessary means that also pose 'potential problems' (ethical, techno-scientific or material-economic) to its human-directed progress which require procedural management and 'mitigation'. Such conceptualisation renders the non-humans into mere instruments of our progress in space – while they are in fact themselves 'instrumental' in establishing and sustaining the extraplanetary domain as a human province.

This lack of non-humans within the current legal and policy registers surrounding global approaches to outer space is part of a larger problematics surrounding both our efforts to relate to its alien expanses and also the ongoing challenge of how to codify and formalise our 'recognition' of nonhumans in general. The momentum of the space age leaves us, as Harold Goodwin wrote, with 'an inadequate vocabulary' [9]. This is most apparently reflected in the vocabulary of space law and policy, the development of which thus far has not been able to keep pace with our extraplanetary advances; concepts such as 'space situational awareness', 'space debris' and 'space tourist' are all without agreed-upon definitions let alone a clearly defined legal status [10–13]. The question of non-humans is one of such disturbances in language that accompanies our progress in space. On earth, non-humans of both the animate and inanimate kind have been gradually recognised as productive participants in biological, technical and social processes that sculpt the gamut of human life.[5] If non-humans are seen as significant for life on earth, they are even more important for expanding its currents beyond the planet. This significance extends beyond the techno-scientific preoccupations with innovation and progress onto a range of legal, political, economic, cultural and ethical issues surrounding space exploration [15–20] and in this sense, their structural absence from the OST is a notable lack which indicates a particular governmental lacuna. It is symptomatic of what Stephen Pyne calls the 'third age'[6] of geographical discovery which focuses upon the extremities of the planet and its surroundings [15,16] and encounters with 'new worlds' which were 'previously uninhabited or visited by humans' [21]. As a part of the 'third age' of discovery, space exploration necessitate 'dramatically different' approaches of transcending not only its ethnocentric origins but also its anthropocentric orientation [21].[7] In this sense, accounting for these earth-born or human-made non-humans and the ways in which their status and contribution is recognised in space law and policy, becomes crucial for affirming the vision of space exploration as shared, collective endeavour and shaping the cosmic horizon of 'more-than-human world' [14].

As further space launches are accomplished, new spacefaring nations inaugurated and novel international, commercial and public-private ventures in space initiated, a more and more-diverse pool of non-humans are sent out to reinforce the extraterrestrial progression of human societies, such as Robonauts and *Sphaerocystis* algae, which have been recently involved in projects on the International Space Station. Their centrality to processes and practices which seek to buttress our extra-planetary prospects affords them a particular status, one which arguably necessitates additions and reconfigurations of global legal and ethical platforms. Acknowledging the participation of these non-humans would shape the direction of our future in space, and give form and language to the complex relationships that will continue to configure our shared making and remaking of the 'more than human world' beyond the boundaries of the earth. As the possibility of encountering 'new worlds' actually becomes literal, and as such encounters become increasingly shared with nonhumans, it seems fitting that our classifications and systems of law and ethics reflect and acknowledge the roles played in space by these heralds of a global collective. Expanding upon this proposition, this paper explores the legal and politico-ethical circumstances that condition the extraterrestrial presence of nonhumans from earth. In overviewing how we define their status within the global statutes of space endeavour, it suggests that they too can be framed as our global 'envoys' – and more precisely, that part of thinking our extra-planetary progress requires formal and conceptual gestures which would account for those non-human space explorers that advance our shared futures beyond the planet.

2. Configuring 'things' in space

Aside from humans, space exploration has mostly relied upon various objects and things – an array of nonliving matter that has been techno-scientifically organised into the material infrastructure that sustains its momentum. If inanimate objects, in particular human-made technologies, are inseparable from, and themselves constitute a gamut of our terrestrial ways of life [37,38], then they are also vital in its extension into outer space. Their apparent indispensability in converting the extraterrestrial environment into a human domain is in a way validated in the OST. Their presence in space is not only addressed in the Treaty's main text, they also take a prominent place in the Rescue Agreement [3], the Liability Convention [4] and the Registration Convention [5]. Like astronauts, they have also been given a distinct designation while residing in space – they are considered as 'space objects'. The definition of this term is provided in Article 1 of Liability Convention which elaborates upon Article 7 of the OST, stating that it 'includes component parts of a space object as well as its launch vehicle and parts thereof' [4]. Such broad classification does not develop any nomenclature for the wide range of space objects that fall into this category. Aside from banning weapons of mass destruction beyond the earth, international space law does not make any distinction between different objects that humans have placed in space – whether between their type, purpose or operative conditions and encompasses anything

[5] Pyne conceptualises the 'third age' of discovery as the period following the great age of maritime discovery and the period of exploration (and colonial exploitation) of non-European continents [15,16].

[6] While the OST in a way overcomes the ethnic and nation-centric gravities of human organization, envisioning outer space as the global commons and its exploration as a pursuit which aspires to benefit the continuum of humanity as a whole, it does not dispense with the anthropocentric lens.

[7] As indicated in the Convention's Annex, this was a response to 'the need to elaborate effective international rules and procedures concerning liability for damage caused by space objects and to ensure, in particular, the prompt payment under the terms of this Convention of a full and equitable measure of compensation to victims of such damage' [4]. Damages caused by space objects are not rare. While most deorbiting satellites and their debris will burn in the atmosphere, some fall back to earth such as the Skylab station that in 1979 crashed on the Western Australian coast, and some remain in orbit and pose a threat to operational space objects such as satellites and the ISS, which occasionally get struck and damaged by debris. However, the liability principle has been thus far only enforced once, in 1978, when the Russian RORSAT Cosmos 954 satellite fell in Canadian territory, prompting a claim and settlement for damages [41].

and everything from simple artefacts and tools to complex technological systems. 'Space objects' range from a bolt lost by the ISS crew and shovels left in the lunar Sea of Tranquillity landing site, to various orbiters, flybys, landers and rovers — and also include all particles of technological debris ever left in space.

While their broad legal classification does not address the specific characteristics of individual 'space objects', the Treaty nevertheless makes clear their legal status as property. At the time when the OST entered into force, its states signatories firmly asserted their ownership and control over the 'space objects' that they launch. The OST's Article VIII advises that 'A State Party to the Treaty on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object, and over any personnel thereof, while in outer space or on a celestial body' [1]. The OST approached 'space objects' as the extraterritorial extensions of launching states and although it envisioned outer space as the global commons which should stay outside territorial claims and ownership rights, it conceived the space objects which are placed in it as domains of property and sovereignty. Along with the development of international collaboration and public-private partnerships in space exploration, more complex property relations have emerged in outer space and there have been further attempts to clarify and strengthen them. The Inter-Governmental Agreement for the ISS for example, regulates all ownership issues within the station which comprises different modules and equipment launched and used by different parties [39]. These include national space agencies such as NASA and Russia's ROSCOSMOS, international space agencies such as ESA and private companies such as Space X which supply cargo to NASA's programs on the ISS. As space exploration advances, the problematics of ownership in outer space also re-emerges beyond the basic activities of placing objects from the earth into outer space, becoming imbricated into the possibilities of creating 'space objects' while in space. The Portal, a recent project of NASA and the company Made In Space to install a 3D printer at the ISS, with which astronauts could print tools and equipment parts, initiates the prospects of the extraterrestrially based production of space objects [40]. Techno-scientific developments such as Portal signpost the further need to evolve legal and policy approaches toward the space objects and the issue of their ownership.

The presence and movements of space objects also become the focus of liability issues. The Liability Convention's Article 7 states that 'a launching State is internationally liable for damage to another State Party to the Treaty or to its natural or juridical persons by such object or its component parts on the Earth, in air or in outer space, including the moon and other celestial bodies' [4].[8] While the focus of the Liability Convention is upon the responsible use and management of space objects and potential damages they can cause to any terrestrially or extraterrestrially based property of states or other parties, it does not encompass the potential damages that they could inflict upon outer space itself. The formation of orbital debris in particular highlights this problematic. Cluttering the earth's environs, each of its many particles belongs to its owner, though in most cases, it is impossible to determine exactly to whom and each of them presents a risk to operational space objects. Orbital debris saturates our planetary surroundings not only by introducing property in the orbital commons, but also by becoming its environmental feature [42]. By conveying terrestrial matter into the earth's outside, space objects are in a way 'damaging' the natural state of the extraterrestrial environment and in this sense, their sheer presence in space itself becomes a shared issue of collective liability and responsibility.

Perhaps more pertinently, the very term 'space object' is one which undermines recognition of the active contribution that certain non-living nonhumans are making to our advances in space. From Sputnik, Mariner, Pioneer and Voyager missions, to space shuttles, Mars rovers, the ISS and Cassei, many space technologies have not only provided infrastructure for space exploration but themselves progressed its routes. Inanimate objects themselves are vital in shaping the courses of human life [43,44] and space objects extend this capacity outside the planet in many different directions, whether as an orbital debris formation which now transforms and affects our uses of the extraterrestrial environment, or rovers sent to explore Mars and enable our remote presence on the red planet. With the ongoing advances in robotics, artificial intelligence and materials engineering, the productive agency of space technologies increases, such as the recent example of the two dexterous humanoid robots, Robonauts that have been sent to the ISS to conduct EVA operations autonomously or alongside of humans [45]. The continuous enhancement of space technologies gradually progresses their capacity for agency, transforming them into more autonomous, not-so-inanimate space explorers. Their undeniable contribution in making possible humans activities in space complicates the ethical registers of their status of inanimate objects. As non-living entities their legal status is that of objecthood and they have no rights or responsibilities which 'subjects' and 'persons' do – these lie upon humans and our relationship with these objects, from their design and construction to the ways in which we use and dispose of them. Yet, although the law logically 'objectifies' space objects, what this fails to recognise, capture and codify are the qualities of productive participation that these objects contribute to the collective endeavour of space exploration. Terrestrial policy falls short when applied to things in outer space. It may not yet have the language with which to soundly acknowledge the participation of nonhumans, but perhaps what is required is a way of extending our ethics which credits those 'things' that act as the foremost envoys of humankind in the 'third age' of discovery.

As more space objects with more sophisticated functions are launched, creating more debris and making possible a host of prospective uses of outer space – and which also may involve all too familiar scenarios of territorial and ownership claims, resource extraction and environmental destruction – they increasingly require articulation of principles and rules regarding their status and performance in space. In the first place, this concerns their too-broad definition as both functional objects and as debris; currently a spacecraft with its entire payload and all of its components are considered a single space object – irrespectively of whether they are joined together or not. More generally, these objects demand attention and redefinition as looming problems – their increasing presence beyond the globe inflects questions concerning the ownership of objects in the shared domain of the commons, and the unceasing creation of debris signals our damaging capacity to make environmental changes to outer space. In this sense, while not sentient or even living themselves, space objects and their conduct become an issue of planetary importance. On an even larger scale, the objects we place in space may become the sole explorers of space. At present most missions are conveyed through technologies which become our only intermediaries and with the number of 'unmanned' technical objects far exceeding the numbers of humans – not to mention the high costs and dangers associated with a human presence, as well as the natural limitations imposed by the space environment – our prospective steps in space may not only continue to be predominantly made by technologies, but could even entirely proceed through them. Such circumstances suggest that the creation of a more-than human world beyond the planet is necessarily tied to the objects we place there, and there is thus a pressing need to define a legal and ethical approach to addressing them. This is particularly so with regard to the mediating 'things' with which we extend ourselves – the animation and contribution of space technologies, in particular will require new terms, new ways of expressing a planetary outlook which is truly collective.

[8] The possibility of conferring the status of personhood on animals has been an evolving topic; for more on this and other legal and ethical issues surrounding animals and their rights, see the work of Steven Wise, Cass R. Sunstein and Martha Nussbaum, Gary Francione, Cary Wolfe and Jamie Lorimer [46–50].

3. Living non-humans in space

Even before the launch of Sputnik in 1957, which marked the official beginning of the space age, various living non-humans contributed to attempts to initiate its momentum and participated in forging paths for human arrival. From 1946, a series of V-2 rocket probes by the United States of America carried several specimens including moss, seeds such as maize, rye and cotton, fruit flies, rabbits, rats, mice and monkeys up to the suborbital regions, aiming to assess the effects of high-altitude environments upon living organisms [22]. During the 1950s and 1960s, the US and Soviet space programs conducted a range of experiments which respectively focused on monkeys and dogs, seeking to evaluate the performance of their vital functions under the high atmospheric pressure, strong radiation and lack of gravity and appraise their capacity to survive such un-earthly surroundings [22]. Most of them did not survive the exposure to the punishing environmental conditions of outer space, whether by accident or through the design of the experiment, including the famous case of Laika [23]. Although these earth-born non-humans played a major role in accomplishing the initial breakthroughs of space exploration, they have been entirely omitted from the OST which came into force in 1967. Instituted amidst the period of Cold War, following Yuri Gagarin's orbital journey in 1961 and anticipating the landing of the human mission to the Moon, the OST exclusively focused upon the human explorers of space. In the ensuing years, ever-diverse flora and fauna nevertheless continued to sustain our extra-planetary aspirations. In 1971, Apollo 14 flew hundreds of tree seeds to the Moon and back [24], the space stations such as MIR provided a means to research plant growth and reproduction [25], NASA launched three biosatellites between 1966 and 1969 [26] and the BION program, initiated by Russia and later joined by other countries, carried on its 11 missions between 1966 and 1996 large biological payloads, including primates [22]. One of the most notable projects in space biology research, the BION also brought to public attention a range of ethical issues surrounding living non-humans in space – yet it was not until the mid-1990s that this prompted institutional gestures to address the conditions of their participation in space exploration.

The BION missions gradually fuelled the ire of animal rights activists; in 1996 this culminated in The People for the Ethical Treatment of Animals (PETA) and other groups intensifying their campaigns against the use of monkeys in BION experiments. They argued that it not only involved severe animal cruelty, but that its costly agendas were redundant and brought no scientific benefits, protesting NASA's participation in the program and appealing upon the US Congress to cut its funding for it [22,27]. These pressures and lobbying strategies resulted in NASA's withdrawal from the BION program in April 1996. Later that year, NASA published a document that outlined major ethical codes underpinning its animal research. Entitled NASA Principles for the Ethical Care and Use of Animals, the document drew upon the Belmont Report from 1978 which established a set of ethical procedures regarding scientific research involving human subjects, aiming to expand its main principles onto animals in space [7]. The document stated that 'a strong allegiance to the principles of bioethics is vital to any discussion of responsible research practices' and that 'the principles governing the ethical evaluation of the use of ANIMALS in research must be made … explicit' [28]. It emphasised that research involving sentient animals necessarily 'involves responsibility, not only for the stewardship of the ANIMALS, but to the scientific community and society as well', and outlined the three 'basic principles' which NASA will 'abide by' in addition to 'all applicable laws and policies that govern the ethical use of ANIMALS' [28]. These 'three principles' established a moral code of 'harm minimization' that included:

> '**respect for life'** - postulating that any animals used in space research 'should be of an appropriate species and health status, and the research should involve the minimum number of ANIMALS required to obtain valid scientific results';
> '**societal benefit'** - suggesting that 'the advancement of biological knowledge and the improvements in the protection of the health and well-being of both humans and other ANIMALS provides strong justification for biomedical and behavioral research'; and
> **'nonmaleficence'** - stating that 'the minimization of distress, pain, and suffering is a moral imperative' for animal research [28].

These codes of NASA's research practice were the first to address the living non-humans in space, setting the foundations of the ethical framework concerning their participation in our extraterrestrial ventures.

Parallel with attempts to order its ethical principles, biological research has itself become even more central to the agenda of space exploration.[9] In 1998, the US National Research Council issued the Strategy for Space Biology and Medicine in the New Century, which recommended that NASA sharpen 'an integrated multidisciplinary approach that encompasses all levels of biological organization … and employs the full range of modern experimental approaches' [29]. In the same year, the biological payload record was set when more than two thousand living beings joined the human crew of seven onboard the space shuttle Columbia (STS-90) for a sixteen-day long NEUROLAB mission [30]. The importance of animals for space research was also validated by the European Space Agency (ESA) in 1999, when, after the initial objection of Germany, the participating states agreed to the experimental use of animals on the ISS [31]. In the ensuing years, the ISS has been becoming more and more important as a setting for biological experiments – currently, living non-humans are vital for research at the station to such a degree that special quarters were built for them to enable continuous and more elaborate experiments. For example, NASA and the Japanese (JAXA) and Italian (ASI) space agencies have been operating rodent habitats, JAXA also maintains an aquarium and NASA is developing a fruit fly habitat system. A series of plant and seed research facilities such as the Lada greenhouse, Biomass Production System and The Vegetable Production System were established on the ISS over the years [32]. While biological research is among the vital imperatives of space exploration, and the aspirations to convene it ethically result in the expansion of various principles and procedures, it nevertheless proceeds as aligned with the codes of conduct which are prescribed by particular space agencies, companies and organisations – there are no global ethical standards that would apply to all spacefaring parties. However, just as concerns about the welfare of animals on earth continues to be pertinent, the importance and ethical problematics of scientific research on organic life in space is also likely to continue to grow. What this suggests, at the very least, is that the ethics of care that we extend to living non-humans should also be judiciously incorporated into global systems of space law and policy.

While these directions of ethical treatment of living non-humans gesture toward attempts to establish a common set of rules and principles underpinning their presence in space, their legal codification within the global endeavour of space exploration reduces these animate organisms to the status of 'things'. On earth, humans are 'subjects', legal 'persons' who have rights and obligations and while some non-living entities such as corporations are also awarded the status of 'personhood', living non-humans are not, irrespective of their capacity for sentience, autonomous behaviour or agency. In outer space, human explorers not only remain citizens of their respective states but the OST also elevates astronauts to our official envoys beyond the earth – a gesture toward conferring on them a kind of global citizenship. Any other terrestrial forms of biological life, on the other hand, are left outside the purview of international space law. Regardless of their part

[9] On the other hand, Article V of the OST mentions life of extra-terrestrial origin: 'In carrying out activities under this Agreement, States Parties shall promptly inform the Secretary-General, as well as the public and the international scientific community, of any phenomena they discover in outer space, including the Moon, which could endanger human life or health, as well as of any indication of organic life' [1].

in a human 'conquest' of space, living non-humans are not recognised as our emissaries, but remain entities for which their respective owners or custodians are responsible.

Central to practices of exercising these responsibilities is the ethical problematics involved in the circulation of biological life outside the earth. The OST's Article IX states 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' [1]. The issue of biological contamination is one of major ethical concerns within space exploration, including both the possibilities of introducing 'extraterrestrial matter' into the ecologies conditioning life on earth, and conveying the beings and matter of terrestrial origin into outer space. These concerns have been solidified into a set of procedures and guidelines aiming to strengthen planetary protection from alien life in the first place, but also to prevent the unintentional and uncontrolled spread of terrestrial life in outer space. These policies are established by space agencies such as NASA's Policy Directive for Biological Contamination Control for Outbound and Inbound Planetary Spacecraft [33] and the Planetary Protection Provisions for Robotic Extraterrestrial Missions [34]. Their provisions are also coordinated and advanced at international levels such as through the International Council of Science's Committee on Space Research (COSPAR) and its Panel on Planetary Protection which consults with the United Nations to develop and issue recommendations about desirable modes of behaviours aimed toward preventing undesirable routes of biological life [35]. In this sense, the participation of living non-humans in space exploration become issues of planetary, or rather extra-planetary importance. The ethical effects of its potential biological influence are suggestive of the need for a coordinated global policy response, one which not only manages and articulates ethical codes toward our treatment of living organisms, but which also frames broader questions regarding the responsibilities associated with their presence in space itself.

At present, international space law is not comprehensive enough to adequately address all the current or potential issues surrounding living non-humans and there are no established mechanisms in place that would guarantee the enforcement of any of its provisions to all state and commercial parties. With the looming possibilities of large-scale space tourism, terraforming and eventual human settlement, the establishment of legal and ethical principles under which the routes of terrestrial life could unfold in space is becoming ever-more pressing. The living non-humans are a constitutive part of this equation, vital for current space research and human futures beyond the globe – they must be accounted for in order for the third age of discovery to proceed stripped of the ethnocentric and striving beyond the anthropocentric, to advance as the collective journey of terrestrial life. Pyne suggests that the third age of discovery opens up questions that exceed the traditional domain of ethics; while its focus upon environments which are unoccupied by humans, or in case of outer space void of any known extraterrestrial life, has thus far 'evaded traditional moral dilemmas of encounters and dispossession', its ethical dimensions nevertheless extend 'beyond the practical bioethics of even deep ecology' [36]. The ethics of space exploration certainly includes living non-humans and suggests the need to expand and coordinate the rules and guidelines in regard to their welfare, but also to officially recognise their overall participation in the extra-planetary unfolding of life at the global scale. Such a revision would have to consider (and find agreement upon) a range of issues related to envisioning a more-than-human world created and sustained beyond the earth: what species would be sent, who gets to choose them and in which particular extraterrestrial direction would the life from earth be further extended? But also, it should secure a legally and ethically sound platform from which to rethink the presence of living non-humans and their contribution in forging our futures in spaces – not only as objects of research to care about, but also as our envoys and companions.

4. Conclusion

The simple fact that terrestrial life has left its home planet is so momentous, that it requires we examine all beings and things involved in it. While humans have led this drive outward, other forms of terrestrial lives, organisms, objects, technologies and tools also accompany them. In essence, humans are never alone in their 'conquest' of space. And as yet the crucial role these nonhumans play on the stage of extraplanetary exploration has not been incorporated in the documents, treaties, polices, and legal apparatus that purport to guide our collective activities in space. As this paper has argued, what is needed in the first instance is an inclusive perspective on the things which contribute to voyages of discovery in the third age, a language which incorporates the others that make this even a possibility. In outer space, nonhumans are participating in a profound expansion of the environment that our species inhabits. They operate increasingly under their own agency, and they do so in an environment potentially free of 'worldly' entanglements – such as divisive national politics and the inwardness of ethnocentric outlooks. Instead, outer space presents a region for policy in which even our anthropocentric perspective could be excised – leaving a slate upon which could be written and articulated new inclusive guidelines and laws for conducting ourselves across the cosmos. The unique circumstances of space exploration – the planetary perspective that it affords and the representative status that it confers – might have the potential to transform how we consider all nonhumans and their 'effects' upon on human worlds. In this sense, the governmental apparatus we develop in relation to outer space may come to serve as a blueprint for how we codify such relations, contributions and participations on earth.

But such speculation aside, what is apparent is that outer space presents a new arena for issues of the commons, for definitions of ownership, problems of liability, responsibility and culpability – and while we increasingly populate this arena with non-humans of terrestrial origin, we have yet to develop policy which keeps pace with these unique circumstances. A place to begin, for example, might be developing policy related to the mandatory and comprehensive collection and cataloguing of exact data concerning the biological life we have sent to space – a 'backdated' equivalent of the United Nations Register of Objects Launched into Outer Space designed for living non-humans. Similarly, expanding the definition of 'space objects' to reflect the many types, categories and consequences of things sent into space would also begin to open avenues for more specific forms and areas of policy making. Outer space thus presents a challenge to law and policy, but one that should be accepted gladly by international governing bodies, as a chance to develop a code of behaviours, to rethink and anticipate how we relate to the beings and things that convey us and accompany us to 'new worlds'. In other words, while the momentum of space exploration has outstripped its governmental frameworks – and this will always be the case – law and policy must continue to evolve in response to a changing human condition. In the space age, this might involve a broader ledger, one which respectfully accounts for the nonhumans which sustain our extraplanetary progress.

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