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Astroenvironmentalism as SF

Bordering (and Ordering) Otherworldly Ecologies

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Abstract The New Space Age is awash with discourses about space colonization and resource exploitation, and these happily coexist with the age-old and curiosity-driven question, “Are we alone in the universe?” Astrobiology addresses this question and, at the same time, codifies knowledge useful for protecting our planet and other celestial bodies from harmful contamination. This article critically examines *astroenvironmentalism* as discussed within astrobiology and attempts to rescue it from becoming a principle of border creation in otherworldly ecologies. To do so, it merges astrobiology with visions and images from feminist postcolonial and decolonial theory, STS, and science fiction, and reflects on the enduring colonial tropes that provide the building blocks of current knowledge on outer space. The same colonial cartographic imagination at play in the much-debated frontier narrative animates the concept of planetary parks. These have gained increased popularity as a mechanism of environmental protection in space, but it is important to note how they entertain a settler future in outer space and legitimize claims to territorial property and extraction. In a dialogue that is contrapuntal to the codification of this form of transplanetary environmentalism, this article traces how Lynn Margulis’s cosmic symbiosis, Donna Haraway’s sympoiesis, and Ursula K. Le Guin’s *The Word for World Is Forest* (1976) intersect with concerns of astrobiological knowledge. Crucially, they enable the blurring of three types of borders: between science and fiction; planetary inside and outside; life and matter. This border-crossing can be generative of a process of creating more-than-human relationalities beyond Earth-centric geographies.

Keywords space ethics, astrobiology, planetary parks, colonialism, symbiosis

Introduction

This article critically examines *astroenvironmentalism*, which refers to the rise of concerns about responsible and sustainable uses of outer space environments. While *astroenvironmentalism* is a label increasingly used to refer to a wide range of environmental issues from the cluttering of orbits to the consequences of deep space exploration, the roots of its development can be traced within the interdisciplinary field of astrobiology. Astrobiology investigates the possibilities of life elsewhere in the universe and of the environmental contamination of space and Earth resulting from exploration

activities. Its biological subject matter is intimately tied to the ethics of space access and use. Famously, in *Cosmos*, astronomer Carl Sagan affirmed that finding evidence of alien life must set the limit to human exploration of space: “If there is life on Mars, I believe we should do nothing with Mars. Mars then belongs to the Martians, even if the Martians are only microbes.”¹ This view remains popular with space scientists and implicates astrobiology, as the science in charge of detecting life, in drawing the borders of what is acceptable human behavior in space.²

While the scientific barriers to having conclusive evidence of extraterrestrial life remain remarkable, exploration of outer space environments and their possible commercial uses continues unabated. At a time when colonization narratives are supported by a widely endorsed commodification of outer space, initiating interdisciplinary conversations on resisting “extraglobal extraction” feels ever more urgent.³ For this reason, this article examines astroenvironmentalism and some of its related proposals for the protection of space that involve borders and parks. Taking on the idea of encircling and enclosing territories through planetary parks, I challenge the imagination of space-based bordering practices that mirror modes of territorial ordering of settler colonialism.⁴ I poke the limits of these existing frameworks and after highlighting their colonial reverberations, I suggest it is fruitful to find a new foundation in Lynn Margulis’s evolutionary biology and the concept of symbiosis. The intimacy of cosmic connections and interrelations demonstrates that space environments should not be thought of as untamed wilderness waiting to be turned into productive territories. It also shows that Earth itself is to be reconsidered as embedded in a wider cosmic ecology.

Then, this article brings in science fiction (SF) and philosophy of science with the aim of rescuing astroenvironmentalism from becoming a principle of border creation in otherworldly ecologies. Following Juan Francisco Salazar’s reelaboration of Donna

1. Sagan, *Cosmos*, 130.

2. A burgeoning literature in the social studies of outer space has focused on astrobiology as a science implicated in this creation of a cultural imagination about outer space. Lisa Messeri’s *Placing Outer Space* has studied the visualization of planetary data in exoplanet research. Bruce Clarke focused on astrobiology’s crucial role in conceptualizing Gaian systems, in *Gaian Systems*. Ethnographies of fieldwork and missions in extreme environments on Earth, which are considered analogous to other planets for some of their physical characteristics (such as aridity, temperature, etc.), have also brought to the fore alternative geographies of cosmic connections. These include Helmreich, *Alien Ocean*; Salazar, “Microbial Geographies”; and Olson, *Into the Extreme*. This article’s culturalist approach folds together fiction and science in a series of conversations about space colonialism and environmental ethics.

3. Klinger, *Rare Earth Frontiers*.

4. Starting with Alan Marshall’s “Development and Imperialism in Space,” human activities in outer space have been unmasked in their colonial and imperial ambitions. These ambitions are materially rooted in land occupation and resource extraction on Earth, such as in the case of the Ariane launch-port in French Guiana analyzed by anthropologist Peter Redfield in *Space in the Tropics*, and permeate the power-dynamics at play in the astrosciences, as demonstrated by Chanda Prescod-Weinstein and cowriters in “Reframing Astronomical Research.” In this context, the frontier metaphor has been questioned for implicitly invoking histories of settler colonialism and expansion toward new territories.

Haraway's polysemy of SF to create a tight coupling of fiction and scholarship,⁵ I posit this interweaving, interdisciplinary narrative as an instance of SF, encompassing science facts, science fiction, and fabulations.⁶ Instead of approaching SF as a literary genre, I read Lynn Margulis and Donna Haraway first, and Ursula K. Le Guin later, in their complex entanglements with each other and in dialogue with astrobiology. In the last two sections, through references to Le Guin's *The Word for World Is Forest* (1976) and its insights on how environmentalist discourses can be co-opted within colonial frameworks, I ask what sort of alternative imagination SF can foster and how it can be read contrapuntally to and as an expansion of circulating scientific discourses on astroenvironmentalism.

Narrating Space Environmentalism

In 1996, astronomer and planetary scientist Carl Sagan taped a message to future Mars explorers. In it, he acknowledged that the astrosciences and SF are in a relationship of constant productive tension and pointed to SF as a source of inspiration for pioneering scientists, including the American rocket engineer Robert H. Goddard and himself. Then he shared his emotion at imagining the first human explorer eventually setting foot on the red planet:

Maybe we're on Mars because of the magnificent science that can be done there—the gates of the wonder world are opening in our time. Maybe we're on Mars because we have to be, because there's a deep nomadic impulse built into us by the evolutionary process—we come, after all, from hunter-gatherers, and for 99.9% of our tenure on Earth we've been wanderers. And the next place to wander to is Mars. But whatever the reason you're on Mars is, I'm glad you're there. And I wish I was with you.⁷

In his reference to SF, Sagan reproduced an idea of the genre as one that primarily pivots around the theme of humans exploring and settling on other planets, following a genetic drive to wander toward other spaces. In this view, reaching Mars is a fulfillment of humanity's next destination and scientists' efforts contribute to this heroic endeavor.

Recently, new rovers have reached the red planet; the launch of anthropogenic objects and the search for new futures beyond our planet have intensified.⁸ In the context

5. Salazar, *Anthropologies and Futures*, 161.

6. Despite this grand interdisciplinary aspiration, this article is limited in scope and remit and by the author's background and positioning within the European academy. It cannot and does not set out to analyze the many literary and philosophical works that have imagined other worlds, including Afrofuturism and Indigenous futurisms. While delimiting the field of my intervention, I also need to acknowledge that Lidia Curti's *Femminismi futuri* has provided me with an example of how to weave together women's narratives to create new ecological frameworks. I hope that my limited act of disciplinary transgression can contribute to stimulating more grounded engagements with diverse literatures to influence science-making.

7. The audio message was recorded and included on two disks carried by landers that were part of the unsuccessful Russian mission *Mars '96*. For audio of the message, see Planetary Society, "Carl Sagan's Message to Mars"; Popova, "Carl Sagan's Message to Mars Explorers."

8. A risk of contamination is posed by objects blasted into space without the appropriate sterilization protocols, as highlighted by the case of Elon Musk's car Tesla roadster, which was carried into space as payload

of Earth's climate crisis and the rise of privately funded spaceflights, the old myth of space as the "next destination," as in Sagan's quote, is now coated in a rhetoric of "salvation." New Space entrepreneurs have popularized the view that Mars could be a backup planet, positing a multiplanetary civilization as the next step of human development.⁹ Space philosophers such as James Schwartz and Tony Milligan have endorsed this view and suggested terraforming Mars as advisable if we are "threatened with humanity's demise."¹⁰ However, in the early 2000s, geographer Fraser MacDonald unpicked the ways in which these discourses on interplanetary travel and human settlements on other planets are underpinned by right-wing ideologies. These define human candidates to cross planetary borders according to narrow and exclusionary neo-Darwinian logics, sometimes downright flirting with eugenics. MacDonald's critique of Everett Dolman's *Astropolitik*—a classic text of space and geopolitics—provides a necessary cautionary starting point to rethink what sort of narratives, tropes, and values are popularized in the dialogue between the astrosciences and science fiction.¹¹ These inform what Kat Deerfield calls "space culture": the "culture found within space science and space industry settings and the broader culture that surrounds this."¹²

Astroenvironmentalism is a useful starting point to counteract New Space discourses on exploitation and extraction of outer space environments. The relevance of thinking environmentally about outer space is eloquently summarized by geographer Julie Klinger: "The manner in which we engage with outer space is environmental, insofar as we transform Earthly environments to get to and from outer space, we use space-based technologies to understand Earthly environments, and our engagement with outer space, whether orbits, moons, asteroids, or planets, has measurable environmental footprints."¹³

These modes of human engagement, including their cost and sustainability, raise questions about the ethics of acting upon off-Earth environments but also point to the necessity of rethinking mainstream images, narratives, and maps of these environments. In this context, astroenvironmentalism can become an alternative to capitalist salvation narratives only if it deals with the colonial legacies of its environmental imaginaries and truly accounts for more-than-human ecological relations that exist within and beyond earthly geographies. I am proposing here a double move: first, thinking about outer space

during the inaugural flight of SpaceX's rocket Falcon Heavy in 2018. A discussion on the dangers of backward and forward contamination is beyond the scope of this article. Government agencies address these concerns within the remit of the international guidelines on planetary protection. Monica Vidaurri and cowriters highlighted that planetary protection should have an explicit anti-imperialist clause; see Vidaurri et al., "Absolute Prioritization." A recent white paper outlined how planetary protection could be a pathway toward establishing anticolonial practices within NASA and other space agencies; see Tavares et al., "Ethical Exploration."

9. Valentine, "Exit Strategy." Tutton, "Multiplanetary Imaginaries and Utopia."

10. Schwartz and Milligan, *Ethics of Space Exploration*, 13.

11. Dolman, *Astropolitik*.

12. Deerfield, *Gender, Sexuality, and Space Culture*, 4.

13. Klinger, "Environmental Geopolitics and Outer Space," 3.

through an environmental humanities lens will allow for a broader interdisciplinary engagement with the ethics of space exploration and use. Second, engaging with outer space studies will change how we think about earthly environments, because it prompts conversations about Earth as an open system—one to be “placed” within the cosmic ecology of the solar system.

Despite the growing literature on environmental imperialism and on the coloniality of space exploration, recently analyzed by Natalie Treviño, the relation between colonial space imaginaries and environmentalism beyond our planet remains under-studied.¹⁴ Linda Tuhiwai Smith’s pathbreaking *Decolonising Methodologies* outlined how the spatial vocabulary of colonialism has created a static understanding of space. Smith discussed three concepts: the line, the center, and the outside, which are fundamental to the colonial marking and control of space.¹⁵ While the line is a tool of control that enables border creation, the center determines an orientation for all that is deemed an “outside.” This same vocabulary is applied to outer space through ideas of bordering, centers, and frontiers.

Scholar Linda Billings—also a consultant for NASA’s astrobiology and planetary defense programs—has recently defined astroenvironmentalism as “a call to preserve pristine extraterrestrial environments for their own sake.”¹⁶ Her definition refers back to astrobiologist Charles Cockell’s argument that we should recognize the intrinsic value of an undisturbed extraterrestrial body as an object of study and of microorganisms found on other planets.¹⁷ Billings’s long-standing concern with the use of the frontier metaphor led her to trace its colonial connotations within the settler history of the United States and to swap this image for that of wilderness:

The wilderness metaphor has been suggested as an alternative to the idea of space as a frontier in the concept of astroenvironmentalism, the idea of applying the values of environmental protection and preservation to space exploration. Treating the solar system like a wilderness to protect rather than a frontier to exploit could keep nuclear weapons, nuclear power, humanmade debris, and environmental hazards out of space and prohibit private and sovereign property claims. The point . . . would be to avoid making the same mistakes in space as we have on earth.¹⁸

If the promise implicit in the exchange of frontiers with wilderness is not repeating the same mistakes made on Earth, it is important to note that images of untamed wilderness in environmental protection discourses have also historically been coterminous with the colonial exploitation of peoples and lands.

14. Treviño, “Cosmos Is Not Finished.” For green and ecological colonialism, see Grove, *Green Imperialism*; Beinart and Hughes, *Environment and Empire*; Moore, “Nature and Origins.”

15. L. Smith, *Decolonizing Methodologies*, 53–55.

16. Billings, “Earth, Life, Space,” 246.

17. Cockell, *Space on Earth*.

18. Billings, “To the Moon, Mars, and Beyond,” 434.

References to empty wilderness in Australia, Asia, and the Americas by European colonial powers obliterated the very existence of Indigenous communities and paved the way for genocide and for the imposition of extractive and profit-driven modes of land management. Indigenous scholars such as writer Fabienne Bayet (Bundjalung/Belgian) and Glen Coulthard (Dene) have looked at the language of wilderness and the environmental governance of parks on Earth as a model of occupation that attempted to erase Indigenous people's ties to their lands and enabled a form of primitive accumulation.¹⁹ Geographer Deondre Smiles (Ojibwe) directly pointed to how, for Indigenous people, the images of space frontier and wilderness are both signifiers of colonialism: the "language surrounding 'frontier' is troubling because it perpetuates the rationale of why the American settler state even exists—it could make better use of the land than Native people would, after all, they lived in wilderness."²⁰

William Cronon's *Uncommon Ground* highlighted that there is nothing natural or benign in the concept of wilderness and that its use may well end up countering its own proposed objectives.²¹ However, despite the existence of a long tradition of critiques of wilderness from Indigenous, postcolonial, and Global South perspectives, the term has been endorsed and heavily used in studies on environmental ethics and outer space for over three decades.²² In *Beyond Spaceship Earth* (1986), a pioneering text on space ethics edited by Eugene Hargrove, essays on environmental perspectives penned by William K. Hartmann as well as Paul F. Uhler and William P. Bishop make explicit reference to outer space as wilderness. Similarly, Cockell's work refers to wilderness as a benign image of space untamed by humans and uses the US Wilderness Act of 1964 to make an argument for the preservation of extraterrestrial planetary environments.²³

One of the policy proposals Cockell put forward with Gerda Horneck is the creation of planetary parks. Largely mirroring national parks, planetary parks are delimited areas on other celestial bodies to be protected because of their "scientific, historical or aesthetic importance."²⁴ These are to be governed by specific rules which would include "no waste to be left in the park, no landing of robotic spacecraft, and movements of people or robotic vehicles only along specified routes."²⁵ This proposal has current traction in relation to the governance of the moon, as organizations like *For All Moonkind* attempt to protect lunar items and landing sites and suggest heritage sites should be secured on other celestial bodies. On Mars, Cockell and Horneck have already pinpointed some suitable candidate areas to become parks, including Olympus Mons or parts of the planet's desert.

19. Bayet, "Overturning the Doctrine"; Coulthard, *Red Skin, White Masks*.

20. Smiles, "Settler Logics of (Outer) Space."

21. Cronon, *Uncommon Ground*, 79.

22. See Guha, "Radical American Environmentalism"; DeLoughrey and Handley, *Postcolonial Ecologies*.

23. Cockell and Horneck, "Planetary Parks."

24. Cockell and Horneck, "Planetary Parks," 256.

25. Cockell and Horneck, "Planetary Parks," 256.

While proposing strict rules on preservation of land in park areas, the perimeter of parks works as a border, out of which other practices become permissible: “[In non-park areas] land can be transformed through labour into productive land by any individual or group of individuals that can find a use for it, and in so doing land becomes their property.”²⁶ Cockell and Horneck admit that planetary parks are only a viable proposition in case distributed life is not found on a planet—in which case the whole planet *may* (my emphasis) become a park. While it is true that planetary parks form part of a repertoire of environmentalist positions within astrobiology, what is their function in an imaginary that does not fall back on colonial logics? I suggest that planetary parks are emblematic of the ways in which astroenvironmentalism endorses Western epistemologies that deny the complexity of environmental relationships enabling life in its multiple forms and see planets as territories that can be parceled and bounded. Smith’s critique of the binding of Euclidian geography with colonizing projects appears as an important aid for thought.

The proposition of planetary parks is unsettling because it allows for permanent changes to be made to parts of an ecosystem and suggests that these can be controlled and delimited through acts of border creation. Under the guise of an environmentalist argument, this hypothesis entertains a settler future in outer space and legitimizes colonial claims to property and extraction. By endorsing a view of outer space as pristine or untouched wilderness, it posits otherworldly environments as existing “out there,” beyond our borders, and separate from “us.” The dialectics of here/there, inside/outside and center/peripheries “place” outer space (borrowing Lisa Messeri’s title) within a colonial cartographic mindset, which admits and allows the possibility of occupation and conquest.

The case of astroenvironmentalism reveals that addressing the issue of colonialism in space requires a paradigm shift, a transformation that goes beyond simply expanding ecological concerns beyond our planet. This reflexive process needs to tackle the ideologies underpinning mainstream conceptualizations of space, because the construction of space as a frontier, an outside, or an infinite void scattered with floating barren rocks pushes human responsibility out of sight. However, in the context of outer space, the antidote to dualisms is not easily found in the scholarship on the Anthropocene, which has not adequately engaged with issues such as off-Earth pollution and resource extraction. In looking for a potentially fruitful entry point for imagining ways of living in the cosmos that do not simply replicate extractive models, in the following sections I enter into dialogue between works on ecology by Margulis, Haraway, and Le Guin.

Relationality Matters: Symbiosis and Sympoiesis beyond the Anthropocene

Critiques of the Anthropocene have been both necessary and insufficient to address environmentalism beyond Earth. If the Anthropocene as a geological era writes itself deep in the strata of Earth, one of its limits is evident: it does not capture the ways in which pollution and exploitation reach beyond our atmosphere—for example in the case of space junk. Anthropologists Valerie Olson and Lisa Messeri’s “Un-Earthing the Anthropocene”

26. Cockell and Horneck, “Planetary Parks,” 260.

highlights that the concept of environment in the literature on the Anthropocene closes in on the terrestrial inner-atmospheric geology and ecology. While useful to draw attention to the importance of ecological relations, its spatial dimension seems to be tightly delimited by the atmosphere: “On the one hand, the Anthropocene concept solidifies the vitally powerful idea that there is no environmental ‘outside’ and that everyday human life is ecological across scales. On the other hand, the concept relies on the knowledge of and reference to remote ‘other’ and ‘outer’ spaces to shape that containing human environment.”²⁷ While conveying the collapse of the boundaries between human and natural domains, many articulations of the Anthropocene as a geological era have spatially resorted to topographies of inside/outside or depth/surface. In doing so, they have overlooked outer space environments.

However, several works have usefully pushed against spatial binaries and opened the possibility of questioning the identification of planetary boundaries with the thin layer of the atmosphere. Mobilizing geographer Doreen Massey’s relational conception of space, MacDonald looked at the role of satellite data and communications and space-enabled technologies in mediating users’ perceptions of life on Earth.²⁸ Jennifer Gabrys highlighted how socio-technical assemblages blur the boundaries between natural and sociocultural domains.²⁹ Benjamin Bratton refashioned the material presence of technology in orbit as another ecology: an ecology of automation.³⁰ In this vein, an ecological lens that includes the socio-technical and biological dependency from space environments and planets in the solar system allows for the emergence of multiple tangles that enable planetary survival. For example, placing the sun as central to the sustenance of life on Earth, Klinger shows that “life and environment, Earth and outer space, are linked in a long series of chemical reactions and flows of electromagnetic radiation.”³¹

The process of swapping frontiers and binaries for this form of relationality calls for a new vocabulary and imagination for earthly-space matters. Donna Haraway’s *Chthulucene*, in its tentacular articulations of intimate human and nonhuman encounters, could helpfully bring outer space into the fold of more-than-human relations. However, Haraway has expressed resistance to extending the reach of the *Chthulucene* beyond Earth.³² For this reason, in what follows, I resort to Haraway’s “webbed ecologies” to begin and resignify the theoretical references of astroenvironmentalism. “Webbed

27. Olson and Messeri, “Beyond the Anthropocene,” 29.

28. MacDonald, “Anti-Astropolitik.”

29. Gabrys, *Program Earth*.

30. Bratton, *Terraforming*.

31. Klinger, “Environmental Geopolitics and Outer Space,” 10.

32. Haraway has often expressed how politically important it is to stay with earthly connections and encounters. She affirms,

The systemic stories of the linked metabolisms, articulations, or coproductions (pick your metaphor) of economies and ecologies, of histories and human and nonhuman critters . . . are terran, not cosmic or blisped or cursed into outer space. The Capitalocene is terran; it does not have to be the last biodiverse geological epoch that includes our species too. There are

ecologies” is a point of departure and a nod to Rachel Carson’s *Silent Spring*, which defined the complex codependency that animates ecosystems as the “web of life.”³³

In the “Cyborg Manifesto,” Haraway wrote that “the boundary between science fiction and social reality is an optical illusion.”³⁴ *Staying with the Trouble* presents Haraway’s own experiments with SF as a creative form of knowledge-making and as an act of world-making, in which the knitting of images and thoughts together is done dialogically with art and science, in an interdisciplinary game of string figures. The material power of stories to create new worlds is captured in the statement, “It matters what stories make worlds, what worlds make stories.”³⁵ For Haraway, the threat of extinction, differentially affecting subjects on a planetary scale, mandates the need for new stories that multiply the possibilities of living together in the complex entanglements of multi-species relationships. Grounding imaginative practices in relational modes of survival, Haraway challenges human exceptionalism of many Earth stories and shakes the logics of extraction that have made up the postcolonial present.

Haraway calls this act of poetic creation “sympoiesis,” or worlding, which stands for “theorizing and storytelling” in which the definition of humanity cannot be disconnected from the encounters that constituted them.³⁶ Living on our planet in ruins requires “sympoietic thinking and action.”³⁷ Sympoiesis, a mode of resistance to dualistic environmental thought, originates in Haraway’s engagement with Lynn Margulis’s microbiology. Margulis defined symbiosis as “interliving” or a mode of creating alliances among differing life-forms.³⁸ She coined the term *symbiogenesis* to address the role of symbiosis in evolution: mitochondria are the trace that merging of two bacteria into a single cell determined the partnership at the basis of multicellular forms of life. This concept disrupted the linearity of neo-Darwinian mechanics of competition and accumulation of mutations, which were considered the main logics of evolution for much of the twentieth century. Beyond the workings of symbiogenesis among critters living in proximity on earthly environments, Margulis also described it as a function of cosmic relations. Margulis used symbiogenesis in ways that demonstrated how relations among different celestial bodies were crucial to the emergence and survival of life on Earth: “Symbiogenesis was the moon that pulled the tide of life from its oceanic depths to dry land and up into the air.”³⁹ The tide that pulled the sea and the energy of the sun enabled the emergence of early life on our planet and support its sustenance.

so many good stories yet to tell, so many netbags yet to string, and not just by human beings. (Haraway, *Staying with the Trouble*, 49)

33. Carson, *Silent Spring*.

34. Haraway, *Simians, Cyborgs, and Women*, 149.

35. Haraway, *Staying with the Trouble*, 39.

36. Haraway, *Staying with the Trouble*, 23.

37. Haraway, “Symbiogenesis, Sympoiesis,” 31.

38. Margulis, *Symbiotic Planet*, 106–7.

39. Margulis, *Symbiotic Planet*, 111.

Margulis's rethinking of life's microscopic and cosmic tangles and her collaboration with James Lovelock in the conceptualization of Gaia "coalesced in research fronts such as Earth's system science and astrobiology."⁴⁰ In astrobiology, symbiosis accounts for the important mechanism that permits survival of life in extreme conditions. However, the full significance of Margulis's arguments remains under-appreciated in astroenvironmentalist discourses. The analyzed imaginaries of frontiers and parks appear as the last bastions of a Euclidian conception of space that does not account for the relational character of life's existence within and in spite of our perceived borders. For example, Margulis views the atmosphere as Earth's circulatory system, with the function of moving gases across space.⁴¹ A vector of movement and relations rather than a border, the atmosphere is part of the same complex matter that makes up our planet: "Many very unusual, highly unstable chemicals exist in Earth's air. These include all sorts of organic compounds from the scent of magnolia flowers to butyl mercaptan, the spray of skunks. Our complex atmosphere reflects the diversity of organisms living on the surface."⁴²

Philosopher of science Isabelle Stengers considers symbiosis as a mode of surviving together that is fundamental to ecological relations: "If ecology is a science of multiplicities, its law cannot be consensus—at the maximum symbiosis."⁴³ In this sense, the ecological feedback loops and complex interactions that materially constitute life urge us to question what borders can really do to obstruct, protect, or halt its movement and propagation. Symptoiesis asks what sort of stories and acts of relational creation can reconstitute us and our place of dwelling and provide new directions for astrobiological and astroenvironmentalist thinking. Margulis's symbiogenesis, Haraway's symptoiesis, and Stengers's call to read symbiosis as ecological law demonstrate that there is a feminist archive of ecological thinking that can be tapped into for discussing not only the biology, but the ethics of life in the universe. Reflections on multispecies justice and generative intra-actions, currently outside mainstream debates on space exploration or space colonization, could thus become a new generative focus. If SF comes to the fore as an aid for thinking critically about space science, one of its effects is unmasking and pushing beyond colonial environmental narratives for the cosmos.

Inhuman Bordering (and Ordering)

Through symptoiesis, the cohabitation of science fiction and science fact transgresses the disciplinary limit between science and art, or science and fiction. In the introduction to *The Left Hand of Darkness* (1969), Le Guin rebels against the way in which SF is often described as extrapolative: "It is supposed to take a trend or phenomenon of the

40. Clarke, *Gaian Systems*, 9.

41. Sagan and Margulis, *Biospheres from Earth to Space*, 13.

42. Sagan and Margulis, *Biospheres from Earth to Space*, 19.

43. Stengers, *Cosmopolitics*, 1:33.

here-and-now, purify it and intensify it for dramatic effect, and extend it into the future."⁴⁴ In opposition to this far too rationalist and simplistic mode of storytelling, Le Guin presents her work as a "thought experiment." Borrowing this phrase from Schrödinger's paradox in physics, Le Guin points to the impossibility of future predictions in quantum mechanics. In the same way, the time of SF cannot be easily pinpointed in the future. Contrary to the linearity of extrapolation, SF takes place in the present of its narration.

Le Guin's work is relevant to situating astroenvironmentalism in the New Space Age because, instead of facilitating escape narratives, it allows us to stay with the trouble of European colonial histories, with their movement of people, plants, bacteria, and viruses, as well as the environmental crisis as the conditions of earthly modernity. Le Guin's critical take on tropes of wilderness and natural resources, on conquest and racialized and gendered violence is clearly expressed in *The Word for World Is Forest*. This work confounds and conflicts the borders between environmental and colonial concerns, humans and nature, and life and nonlife. Written as a commentary to the Vietnam War, this colonization narrative presents a world where humans have found an abundance of wood: a resource unavailable on the "worn-out Earth."⁴⁵ The colony of New Tahiti is covered in forest and the fantasy of the colonizer—whose violence is embodied by the character of Captain Davidson—is to cut it down in an act of "world-taming."⁴⁶

The colonizing machine, which sees "New Tahiti as intended for humans to take over," is wrapped in a developmental narrative that promotes a scientific approach to land management and a form of conservation that is not contrary to extraction.⁴⁷ Davidson's plan is the creation of a managed form of monoculture, through soybean farms that in time will replace the trees. Davidson "couldn't see why a soybean farm needed to waste a lot of space on trees if the land was managed really scientifically."⁴⁸ This view of forests as wasted space runs against the environmental guidelines of the ecological officer Kees. The colony's regulations rely on a bureaucratic apparatus made up of ecological officers and environmental protocols. Their objective is to supposedly protect the precious forests and alien critters, while subjecting the inhabitants of the colony to forced labor.

The spectrality of colonialism emerges as part and parcel of this drive to scientifically order, manage, and exploit extraterrestrial environments. The ordering practices that follow uphold anthropocentrism and the hierarchical character of human/nonhuman relations. Davidson, in discussion with Kees, is quick to establish a dividing line between the interests of environmental preservation and the need of resources for the colonists:

44. Le Guin, *Left Hand of Darkness*, xiii.

45. Le Guin, *Word for World Is Forest*, 13.

46. Le Guin, *Word for World Is Forest*, 13.

47. Le Guin, *Word for World Is Forest*, 16.

48. Le Guin, *Word for World Is Forest*, 11.

see, you want to keep this place just like it is. . . . Like one big National Forest. To look at, to study. . . . See where we differ is that with you Earth doesn't come first, with me it does. . . . And when I say Earth, I mean people. Men. You worry about deer and trees and fibreweed, fine, that's your thing. But I like to see things in perspective, from the top down, and the top, so far, is humans.⁴⁹

In this succinct dialogue, Le Guin unmaskes the way in which human exceptionalism is shorthand for the "right" to colonize. But it also shows how environmentalist discourses coexist with and even support colonial practices. The environmental protocols and scientific knowledge collected about alien environments will eventually aid the process of annihilating the Athsheans.

There is a parallel in the ways in which the image of the National Forest emerges in *The Word for World Is Forest* and Cockell's astroenvironmentalist idea of planetary parks, which I discussed earlier in this article. While Davidson points to the absurdity of transforming a whole planet into a protected area, the idea of delineating bordered reserves for environmental protection is wholly compatible with his colonizing ambitions. While in their scientific formulation, planetary parks come into play only for locations where life has been judged to not exist (on the planet or in specific areas); they are not an antidote to settlements or use. Parks appear to constitute a possible exception to the use and extraction of resources, which intrinsically means condoning capitalist exploitation on other planets. Also—as I discuss more below—the border between life and nonlife that justifies a different ethical disposition toward environments is itself called into question in *The Word for World Is Forest*.

In Davidson's statement, the ladder of conquest and progress, which sees Earth at the top, points to the interplay between humanism, as a logic of European colonial enterprises, and the material extraction of value from otherworldly environments. His Earth-centrism points to a gendered and racialized concept of Man as a colonial and European construct.⁵⁰ This concept narrowly closes upon itself to justify resource exploitation: "Wood came only from trees. And it was a really necessary luxury on Earth. So the alien forests became wood."⁵¹ Le Guin uses the description of the wood as a product, disconnected from the lives of the trees and those of the beings that depended on them, to demonstrate that under the intertwined conditions of coloniality and capitalism the categories of the human and inhuman are implicated in one another.

The commodification of the forest into wood breaks down another fictitious border: between the wood and the inhabitants of New Tahiti, between life and nonlife. Le Guin shows the irony intrinsic in the positing of the soil as inert, as nonlife, while earthlings are literally made of it: "So earth, terra, tellus mean both the soil and the

49. Le Guin, *Word for World Is Forest*, 14.

50. Wynter, "Unsettling the Coloniality."

51. Le Guin, *Word for World Is Forest*, 15.

planet, two meanings and one. But to Athsheans, soil, ground, earth was not that to which the dead return and by which the living live: the substance of their world was not earth, but forest. Terran man was clay, red dust. Athshean man was branch and root. They did not carve figures of themselves in stone, only in wood.”⁵² This semantic confusion between life and nonlife, between forest and wood, and dust and soil, of which Athsheans and earthlings are made, is generative: it allows for questions to be raised about who/what deserves preservation and respect, according to which frameworks, and how different ethical dispositions could have fostered different ecological relationships.

Scientific management of the land is code for deforestation: the indiscriminate felling of trees for wood leads New Tahiti ever closer to ecosystem collapse. Any world is its ecology: “A forest ecology is delicate one. If the forest perishes, its fauna might go with it. The Athshean word for world is also the word for forest. . . . Though the colony may not be in imminent danger, the planet is.”⁵³ In this story of interrelations, Davidson’s illusion of dominating the colony crashes in his final awareness of being trapped in another world in ruins. The deadly practices that had caused the extinction of some Terran life-forms, exemplified by the lack of trees, point toward a new Anthropocene away from Earth. While this threat of ecosystem collapse looms large, *The Word for World Is Forest* horrifically depicts how the “inhuman,” nonlife, becomes a discursive construct in support of colonization and genocide.

Here, postcolonial and posthuman literatures are useful to analyze how the conceptualization of the Anthropocene as a geologic era cannot be disjointed from its historical relation with the extractive economies of European colonialism and slavery. For geographer Kathryn Yusoff, geology as a grammar and a language of modernity reflects the geographies and genealogies of colonial extraction in a double sense, “first in terms of settler colonialism and the thirst for land and minerals, and second as a category of the inhuman that transformed people into things.”⁵⁴ New Tahiti presents this very same pattern of colonialism and commodification of environments, resources, and life. The juxtaposition of ecological relations, resource exploitation, and planetary colonization interrogates contemporary discussions about the ethics of exploring and exploiting other planetary bodies. Le Guin’s work, however, does not merely caution us against the current narratives on settling on Mars as an escape from Earth’s damages. It fundamentally tackles the biocentrism of some astroenvironmentalist arguments that do not account for ecosystem approaches to space environments. Bordering parks will not prevent changes to alien ecosystems contaminated by earthly bacteria and will not stop such modifications from reaching areas designated as being of special interest.

52. Le Guin, *Word for World Is Forest*, 72.

53. Le Guin, *Word for World Is Forest*, 60.

54. Yusoff, *Billion Black Anthropocenes*, 68.

Entangled Astroenvironmentalism

In *The Word for World Is Forest*, the ecological officer Kees holds the illusion that colonizing or terraforming activities can be kept under control, so to avoid worldly destruction. However, the fallacy of this argument lies in not accounting for the relational dependencies among different life-forms and among life and nonlife. Keeping environments as intact as possible via national parks or planetary parks is unveiled as another colonizer's fantasy, rendering the existing version of astroenvironmentalism predicated on bordering practices and spatial binaries unsustainable in its complicity with resource exploitation.

Given the prominence of tree felling in Le Guin's work, it is interesting that Cockell's own work espouses an analogy between respecting microbes on other planets and tree preservation. Cockell compares the eventuality of having to disregard the intrinsic value argument with regard to alien microbes to Robert Attfeld's ethical view on felling trees:⁵⁵ "We may be forced to disregard the interests of microbes in many situations (but not all), but this is not to make the individual microbes of no ethical relevance in themselves."⁵⁶ While reaching for analogy to environmental ethics, Cockell fails to account for the potentially devastating consequences of environmental changes that both tree felling and permanent changes to planetary environments can engender. Natural reserves and national parks have not protected our planet from the scale of changes introduced by anthropogenic activities—to the contrary they have served colonial and capitalist gains through land occupation. In the same way, planetary parks cannot protect otherworldly environments from permanent changes and are more likely to become a proxy for space-territorial bounding and control in the hands of powerful geopolitical actors.

In a commentary to *The Word for World Is Forest*, Le Guin highlighted that she wrote the novella at a time when "it was becoming clear that the ethic which approved the defoliation of forests and grainlands and the murder of non-combatants in the name of 'peace' was only a corollary to the ethic which permits the despoliation of natural resources for private profit."⁵⁷ "Ethical calls" can be made to serve the interest of capitalism as a system of oppression and transformation of labor and life into profit. If astroenvironmentalism condones resource extraction, it loses its appeal as a justice-driven concern and cannot be a catalyst for future-oriented and socially engaged science.

From the point of view of astrobiology, it is important to note that in *The Word for World Is Forest* the discipline and its knowledge are subsumed into the settlers' plans for biological domination; Le Guin imagines the apparatus of the environmentalist colonizers as one made of ecological officers, anthropologists, and astrobiologists/exobiologists.⁵⁸

55. Attfeld, "Good of Trees."

56. Cockell, "Ethical Status," 170–71.

57. Le Guin, *Word for World Is Forest*, 7.

58. Le Guin, *Word for World Is Forest*, 83.

Reading Le Guin and Haraway together, it becomes clear that replicating a worldview that is predicated on human exceptionalism and its mastery over environments is a recipe for further destruction. It overlooks the ways in which ecologies, on and off Earth, are entanglements of different lives as well as of life and nonlife. These tentacular tangles cannot be kept at bay through bordering processes.

Ecology for Haraway, Le Guin, and Stengers is in fact a word for tangles and an ethico-political proposition grounded in feminist theory.⁵⁹ For Haraway, “ecology is inspired by a feminist ethic of response-ability . . . in which questions of species difference are always conjugated with attentions to affect, entanglement and rupture; an affective ecology in which creativity and curiosity characterise the experimental forms of life of all kinds of practitioners, not only the humans.”⁶⁰

Speculative Fabulations here emerge as a genre that substitutes normative ethics with a call for reimagining interrelations within and beyond existing asymmetries. Le Guin is attentive to multiple ecological dependencies and puts the spotlight on the ways in which the border between life and nonlife is arbitrarily drawn and continuously transgressed. Similarly, in thinking of “ecosystem networks,” Margulis looks at how chemicals and minerals enable life’s transformation and reproduction.⁶¹ For example, with the expansion of early life from the sea to land, new architectures of life were created to transport nutrients such as sulfate and phosphorous to land. The connectivity and cyclical nature of ecosystem feedback negates the unsurmountable barriers that anchor our epistemologies to hierarchical orders and neatly divide life from nonlife.

Symbiosis in this article has been a figure of this transgression. Beyond Margulis’s bacterial ecology and her view of evolution via indigestion, symbiosis has pointed to the ways in which lives on Earth are reliant on cosmic ecologies, forces active at the level of the solar system and ecological dependencies that are difficult to trace and easy to mess with. Myra Hird and Yusoff’s work on mineral evolution as a symbiotic relation is an example of how post-Anthropocenic environmental imaginaries can present environments in their radical interdependencies. Hird and Yusoff, quoting Paul Gillen, see “the distinction between life and nonlife [appears] not as a clear division but as a tangled chemical continuum.”⁶² *Tangles* and *continuum* are useful descriptors for thinking about sustainable response-abilities, or our capacity to act responsibly, on and beyond our planet. Instead of exits and borders, webbed imaginaries help us stay with the troubles of the interconnected colonial histories and geographies and their legacies pervading environmentalist claims.

59. Stengers, *Cosmopolitics*, 1:32.

60. Haraway, “Symbiogenesis, Symptoiesis,” 32.

61. Margulis, *Symbiotic Planet*, 109.

62. Hird and Yusoff, “Lines of Shite,” 275.

Conclusion

Referring to Le Guin's 1986 essay "The Carrier Bag Theory of Fiction," where she suggests that the first historical artifact was a container, not a weapon, Haraway imagines the feminist and ecological act of terraforming our damaged planet not as one driven by technologies but as the collection of small seeds and ordinary materials for telling new stories. Stories that will be, in Le Guin's words, "full of beginnings without ends, of initiations, of losses, of transformations and translations, and far more tricks than conflicts, far fewer triumphs than snares and delusions; full of spaceships that get stuck, missions that fail, and people who don't understand."⁶³

We need new stories to reimagine the ecologies beyond our planet. The outlined feminist speculative imaginary, which spans science and fiction, proposes astroenvironmentalism as a project not predicated on conquest, progress, or final redemption. The emphasis on progress, underpinning Sagan's remarks on outer space as the next step of humankind at the start of this article, is displaced by the spatial imaginary of ecological relationality, cycles, and continuums. This sympoietic project provincializes the fixation on men as heroes, victorious or tragic or both, and the techno-scientific objective of rehabilitating old views of habitable environments.⁶⁴

Instead of a form of SF that becomes the mythology of modern technology or science, a feminist and speculative form of astroenvironmentalism proposes a different idea of ethically engaged science that is oriented toward sustainable futures: a cultural carrier bag rather than weapon of domination. In this light, astroenvironmentalism becomes a tool to question the ways in which colonial borders define our scientifically mediated relation with the cosmos, and a stepping stone to transgress them. Starting from the cosmic relationality in which Earth beings are embedded can prompt new interdisciplinary conversations about not threatening the integrity of other planetary bodies through extractive actions and how to do science respectfully both in earthly and on alien environments. A new agenda for astroenvironmentalism, resting on feminist and anticolonial genealogies, can start to imagine how to "cultivate robust response-ability for powerful and threatened places and beings" on and beyond Earth.⁶⁵

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63. Le Guin, *Dancing at the Edge*, 153.

64. Hird and Yusoff, "Lines of Shite," 268.

65. Haraway, "Symbiogenesis, Symptoiesis," 33–34.

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