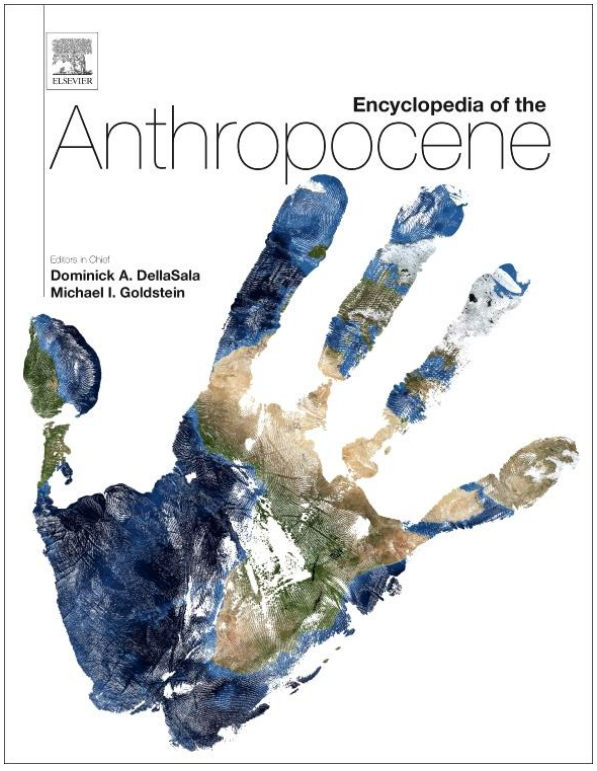

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Cosmology and Ecology

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Historical Overview

Humans, throughout their evolution, have used stories, images, and symbols to understand themselves and the world around them. Different understandings have emerged with the ongoing development of arts, religions, philosophies, and sciences. The complex and uncertain dynamics of the Anthropocene are compelling humans to revisit and reconstruct those understandings, to rethink what it means to be human (*anthropos*) during an epoch in which the planetary scale of human impacts are inextricably entangling human history and natural history. Understanding the planetary presence of the human species requires an understanding of the relationships between the life, land, air, and water of Earth as well as an understanding of the cosmic context in which human-Earth relations are situated. In other words, understanding the dynamics of the Anthropocene requires an understanding of ecological and cosmological perspectives.

In recent decades, humans have learned an unprecedented amount of information about the ecological and cosmological contexts of human-Earth relations while simultaneously realizing the vast scale with which human activities are destabilizing and destroying the conditions of life on Earth. The irony of that situation conveys a sense of urgency. The ways that contemporary humans understand and respond to the planetary scale of their actions are of critical importance for the future of life on Earth. Understandings of cosmological and ecological perspectives bear upon global climate change, the current mass extinction of species, freshwater scarcity, and other urgent problems already facing life on Earth. Accordingly, cosmological and ecological knowledge is not simply a matter of collecting data or communicating facts. It is a matter of informing the values that ground and orient human behaviors, decisions, and institutions. During a time of massive and uncertain transformation, cosmology and ecology are relevant to all humans, not just scientists. Along those lines, cosmology and ecology can be thought of not merely as scientific endeavors but as cross-disciplinary modes of inquiry that involve scientific perspectives entangled with ethics, politics, and cultural traditions.

The importance of cosmology and ecology for human existence is becoming more urgent and more explicit in the Anthropocene, but its importance is not new, as is evident from a consideration of the history of cosmology and ecology. To some extent, one can find cosmological and ecological perspectives throughout the history of human interpretations of the world and the place of humans therein. Scientific cosmology as the study of the structure and dynamics of the universe can be said to begin with ancient Greek thinkers such as Pythagoras and Aristotle around the 5th century BC. However, the roots of cosmology extend much further. Interpretations of the universe can be found throughout human cultures, beginning in the symbols and artifacts of Paleolithic peoples, for whom a sense of the universe is inscribed in cave paintings, burial sites, and figurines (North, 2008). Early interpretations of the universe can also be found in the narratives and astronomical observations recorded in the Mesopotamian, Egyptian, and Chinese societies that emerged after the Neolithic Revolution, which took place around 10,000 BCE, approximately the same time as the beginning of the Holocene Epoch. Similar to the situation with cosmology, while scientific ecology as the study of relations between organisms and environmental conditions began with the German biologist Ernst Haeckel, who coined the word *oecologie* in 1866, proto-ecologists have been undertaking inquiries into organism-environment interactions for thousands of years (McIntosh, 1985).

Cosmological and ecological inquiries are often connected. This is evident conceptually, as symbols and stories that relate to Earth overlap with symbols and stories that represent what transpires in the sky and beyond. Cosmogonies, that is, stories about the beginning (*genesis*) of the universe, often include stories about the beginning of Earth, its various life forms, and the cycles of its seasons. These connections are also evident practically, as understandings of the sun and the stars inform practical decisions regarding activities like navigation, hunting, and farming. These connections can be found in the inauguration of scientific inquiries into nature, which emerged in Greece around the 6th century BC. Some of the earliest scientific inquiries have their expression on the threshold between the imaginative storytelling of myth and the rational argumentation of logical thought. For instance, in Plato's dialogs, descriptions of the universe include logical accounts of mathematical proportions and empirical observations alongside mythic descriptions that convey a sense of the cosmos through images and metaphors, like the analogy for which the world is like a giant organism with its own world soul.

In the works of Aristotle, Plato's student, a more rigorously scientific perspective can be found. Aristotle's investigations into nature synthesize and critique the accounts of his predecessors while articulating rational arguments and empirical observations to account for celestial as well as terrestrial phenomena in terms of principles like motion, space, time, and causality. Earth is envisioned at the center of the universe, surrounded by concentric celestial spheres that hold the stars and planets. The motion of the spheres causes the motion of things on Earth, and an unmoved God is the eternal source of all motion. Although there is much overlap between earthly and cosmic phenomena for Aristotle, he also makes a significant distinction between them, separating the terrestrial motion of elements, plants, and animals, whereby there is a beginning and end for every individual thing, from the circular and thus eternal motion of the stars and heavenly spheres. The terrestrial realm includes everything from Earth to the moon, and is thus referred to as the sublunary sphere, in contrast to the stars, planets, and spheres above the moon (i.e., superlunary).

Aristotle's cosmological framework was further adjusted and elaborated by subsequent thinkers, including Ptolemy in the 2th century CE. Ptolemy is most associated with the geocentric cosmology that was predominant in the Western world during the ancient and medieval periods. That geocentric perspective was challenged by the Copernican Revolution, which began when Nicolaus Copernicus (1473–1543) proposed a heliocentric framework, wherein the Earth is not the center of the universe but is in motion, rotating on its axis and revolving around the sun. Copernicus was not without predecessors. For instance, Aristarchus of Samos proposed a heliocentric paradigm in the 3rd century BC, although it was ignored in favor of the popularly accepted geocentric model. The Copernican Revolution erased the sublunary/superlunary distinction by accounting for all terrestrial and celestial phenomena as exhibiting the same kind of motion. The articulation of the law of universal gravitation and laws of motion by Isaac Newton (1642–1727) can be seen as the culmination of the paradigm shift begun by Copernicus.

The Scientific Revolution extending from Copernicus to Newton provided the conditions for modern accounts of the interconnectedness of humans, Earth, and the cosmos. In some accounts, this interconnectedness is nothing but the interlocking parts of a meaningless machine, while for others it is a meaningful revelation of beauty and order reminiscent of the Greek word *kosmos*, which connotes a sense of the world not simply as order but as a harmonious and beautiful order. That sense of *kosmos* as beauty is found in the word "cosmetics." One of the most influential presentations of a vision of nature in which humans, Earth, and cosmos are interconnected in a beautiful order is Alexander von Humboldt's *Cosmos* (Wulf, 2015). Published in five volumes between 1845 and 1862, *Cosmos* presents the integrative vision that Humboldt acquired through his extensive travels and studies. His work synthesized, popularized, and advanced the scientific knowledge of his day, influencing the works of numerous scientific and literary figures in his own and subsequent generations, including Romantic poets like William Wordsworth and Samuel Taylor Coleridge, naturalists like Charles Darwin and Ernst Haeckel, American transcendentalists like Ralph Waldo Emerson and Henry David Thoreau, the preservationist John Muir, and many others. Approximately 130 years after Humboldt's work, Sagan (1980) published his *Cosmos*, which followed Humboldt in providing an accessible synthesis that represents the current state of scientific knowledge. In the intervening period of time, sciences underwent many upheavals and new developments. The cosmological and ecological insights that developed following Humboldt's *Cosmos* became situated in a more dynamic framework, one for which all life and even the universe itself is undergoing a process of evolution.

In biology, Darwin's theory of natural selection facilitated widespread acceptance of the notion that species are not static kinds but emerge through evolutionary processes, developing in relationship to the selective pressures presented by environmental conditions. Influenced by Darwin's account of biological evolution, the German biologist Ernst Haeckel proposed a scientific study of the relationships between organisms and their environmental conditions. The study of these relationships would comprise something like a study of the economy of nature, or what Haeckel called *oecologie*, translated into English as "ecology," meaning a study of (*logos*) nature's household or dwelling (*oikos*). Haeckel inherited the tension between two perspectives that had been predominant since the development of ancient Greek sciences. As the environmental historian Worster (1994) describes this tension in his account of the history of ecology, it involves a contrast between a perspective that affirms the interdependent coexistence of life on Earth (an arcadian view) and a perspective that aims to control life and organize it into a hierarchy where it has less value, vitality, and intelligence than humans (an imperial view). On one hand, Haeckel and many subsequent ecologists celebrated the interconnectedness of life, but on the other hand, they frequently employ mechanistic explanations of that interconnectedness. By describing organisms and environments primarily in terms of passive, material mechanisms, ecologists fail to account for their dynamic activity and self-organizing interconnections.

A mechanistic orientation in ecology gained predominance after Haeckel. The favored methods employed thermodynamics and economic models of production, consumption, and efficiency to describe ecological communities or ecosystems, measuring the ways that energy is variously transformed through interactions between plants, animals, soil, water, air, and sunlight. Along with the narrow scope of this mechanistic view, which reduces everything to energy flows, another shortcoming of this approach is that, by viewing ecosystems as inherently stable and orderly, it was difficult for ecologists to account for the role of uncertainty, disorder, and unpredictability in ecosystems. This was resolved with the introduction of chaos theory into ecology in the 1970s and 1980s. This provided models and metrics to scientists for analyzing the unpredictable dynamics that accompany ecosystem disturbances and underlie any ostensible balance that ecosystems exhibit. In this view, the energy flows of ecosystems are less like stable and orderly systems and more like dynamic, intricately textured patches that shift and change in complex and unpredictable patterns. Alongside the ecological science developing in the second half of the 20th century, many scholars in the humanities began taking up ecological perspectives, organizing studies of environmental ethics, environmental esthetics, ecofeminism, political ecology, environmental justice, and the spiritually informed model of deep ecology, all of which indicate the persistence of the arcadian view of the natural world.

While ecology and evolutionary biology were developing, a radical upheaval took place in cosmology. In the 20th century, cosmologists came to the consensus that the universe is evolving. Two observations were particularly important for development of an evolutionary approach to cosmology. First, in the 1920s, Edwin Hubble observed through the use of a high-powered telescope that distant galaxies are moving further away from our galaxy, the Milky Way. This is evident in the changing color with which distant galaxies appeared. Hubble noticed a shift into the red area of the color spectrum (redshift), which indicates that an object is moving away from the observer, whereas a blueshift would indicate an object moving closer, and no color shift would indicate a stable object. This provided evidence that the universe is expanding, which suggested that perhaps the universe had an explosive beginning, starting from a very small state and expanding to the size it is currently. Evidence for such an explosive beginning or "Big Bang" came in the 1960s, when Arno Penzias and Robert Wilson observed thermal radiation left over from the initial eruption of the universe. This radiation appeared as a dim glow in the background between stars, showing up faintly in the microwave region of the

radio spectrum, and it is accordingly called the Cosmic Microwave Background. This demonstrated that some inflationary event took place approximately 13.8 billion years ago, and the universe has been expanding ever since. Discoveries in the 1990s led scientists to hypothesize the existence of dark energy to account for the fact that the rate of cosmic expansion is increasing. Dark energy is not to be confused with dark matter, a kind of matter that does not interact with the electromagnetic spectrum but can be inferred from astronomical observations. The concept of dark matter was first proposed in the 1920s. The majority of the mass-energy in the universe is dark energy (~68%), and dark energy and dark matter combined constitute approximately 95% of the total mass-energy of the universe.

Previous scientific developments from Aristotle and Ptolemy to Copernicus and Newton all assumed that the universe is static, like a giant sphere or container within which events transpire. The new evidence that emerged in the 20th century indicated that the universe is itself evolving. Not only is everything in the universe changing, the universe itself is changing, too, and there is much more to the universe than is visible to human observation. Alongside the emergence of ecology and evolutionary biology, this evolutionary perspective in cosmology changes everything, compelling humans to reexamine their understanding of their place in the universe.

A New Story

The evolutionary perspectives of cosmology and ecology describe the natural world as dynamic, generative, and interconnected. What was thought to be a static universe is actually changing, and the entities in the universe are not passive, inert substances, which are best described in mechanistic terms, but are enacting processes of self-organization, such as the self-organizing dynamics whereby the first stars formed out of massive clouds of hydrogen and helium, and the self-organizing dynamics whereby species evolve and organisms live and move. For the cultural historian Thomas Berry (1914–2009), this new information coming from cosmology and ecology calls for the development of a new story of the universe, that is, a narrative that conveys these evolutionary perspectives and their implications for human beings. It would be a story of the evolutionary journey of the universe and everything in it. In this journey, humans are not the only or primary center of meaning and value in the world. In other words, humans are not the only subjects in a universe of mere objects. Rather, the dynamics of self-organization that characterize human agency and intelligence are found in different forms throughout life on Earth and, indeed, throughout the whole universe (Kauffman, 1995). As Berry puts this in *The Universe Story*, which he co-authored with the cosmologist Brian Swimme, the universe is less like a "collection of objects" and more like a "communion of subjects" (Swimme and Berry, 1992, p. 243).

The new story is not merely a story with which one can communicate about the evolution of matter, life, and humans. One of the implications of an evolutionary perspective on the universe is that the universe is itself something like a story. The universe can be described in terms of a narrative structure, having a specific beginning 13.8 billion years ago, with subsequent events unfolding over time, each of which has its own story. If the universe is structured like a story, then part of the task of telling the new story is to show how no telling is ever isolated. Every particular telling of the universe story participates in the encompassing processes of the Earth community and the whole universe. There are countless ways to tell the story, depending on the specific conditions available for the storyteller and for those who might share in it. To convey the basic dynamics of the storied existence of the universe, Swimme and Berry (1992, p. 71) articulate the "cosmogenetic principle." It accounts for the evolutionary becoming of the cosmos in terms of three main aspects: differentiation, subjectivity (or self-organization, "autopoiesis"), and communion.

Differentiation refers to the objective differences that distinguish entities from one another. It can be seen in the uniqueness of every particular thing, system, or event, such as the specific characteristics differentiating one galaxy from another and from other entities, whether stars, atoms, black holes, trees, animals, bacteria, fungi, planets, humans, etc. The counterpart to the objective differences between things is the subjective or self-organizing dynamics of complex systems and living organisms. Differentiation can be thought of as the exterior aspect of the universe, and self-organization can be thought of as the interiority of the universe, that is, the inner agency or subjectivity of things, which can also be thought of in terms of a soul or a sacred quality of things. It is the activity whereby anything is itself, from the self-organizing dynamics of a galaxy or a star to the agency of animals and the subjective awareness of human beings. Alongside differentiation and self-organization, the third aspect of the cosmogenetic principle is communion, which refers to the interconnectedness whereby different things connect and interact. In the evolving context of cosmology and ecology, to be is to be related. The very identity of any matter, life, or human is dependent on and generated from its relationships with the world around it. Not all connections are the same, nor are they all beneficial, but all things are variously interacting with their surrounding conditions, coexisting in some kind of connectivity, communication, or communion. Gravitational attraction is a form of communion, so is ecological interdependence, and for humans love is a form of communion. By understanding the universe as a communion of different subjects, one discovers oneself while also discovering the Earth community and the whole universe. The evolutionary story indicates that humans are woven into the ecological interconnectedness of the Earth community, and Earth is itself woven into the complexity and self-organization of the whole universe. Ecology in this sense is not separate from cosmology. Rather, ecology is cosmology functioning at the scale of terrestrial coexistence, integrating the same dynamics of differentiation, self-organization, and communion. Berry (1999, p. 84) puts this point succinctly: "ecology is functional cosmology."

A key aspect of the new story is that, like other narratives developed throughout the world's cultural traditions, it does not simply disseminate facts but also informs the values that ground and orient human activities. Conveyed as a narrative, the information presented in cosmology and ecology connects scientific perspectives with all aspects of human endeavor. In particular, it challenges

ethical assumptions and norms for which the human being is the sole or primary locus of value in the universe, a position typically referred to as anthropocentrism or human exceptionalism. For anthropocentric ethics, nonhuman modes of existence have value mainly in terms of the use to which humans put them. Animals, in this view, have value as sources of food, labor, or companionship for humans, but they do not have value in themselves, and trees have value as raw materials for construction or as sources for recreation, but they do not have value intrinsically. The epic of cosmic, terrestrial, and human evolution gives lie to any pretense to human superiority. In the context of the new story, all things—material, living, or human—possess intrinsic value by virtue of their capacities for self-organization and communion. Respecting and caring for the values inherent throughout the natural world is not only beneficial for nonhuman members of the Earth community. It is also beneficial to humans. When humans nurture and conserve the world around them, they are nurturing and conserving the conditions that support the health and well-being of humans. To destroy one's own environment is ultimately to destroy oneself. Biocide is ultimately suicide.

This shift toward nonanthropocentric ethics opens out into a universe in which everything is a center of value. Such a shift supports efforts to protect animal rights and the rights of nature. More generally, this shift is indicative of what Berry (1999, p. 3) refers to as the "Great Work" that humans must take up during the current evolutionary moment. "The Great Work now, as we move into a new millennium, is to carry out the transition from a period of human devastation of the Earth to a period when humans would be present to the planet in a mutually beneficial manner." In earlier periods, the Great Work was different. It changes depending on the particular context. For instance, the Great Work of classical civilizations in China, India, and the Mediterranean was to bring forth the world's religious and philosophical traditions, and the Great Work of the indigenous people who first came to the Americas was to develop intimate rapport between people and places. The Great Work now is to transition away from the mode in which humans view themselves as dominators and masters of their environment, toward a mode of mutuality, in which humans view themselves as members of "a single integral community" in which humans and nonhumans are intimately interrelated (4). The new story of the universe provides a context within which humans can carry out such a transition. It provides a context within which the small-scale perspectives of everyday human activities can expand to take large-scale phenomena into account, such as ecological communities and ecosystems as well as planetary systems such as the hydrologic cycle and the global climate. This is directly relevant to the challenges facing humans and life on Earth during the Anthropocene. Indeed, in the large-scale perspective of the universe story, the transition out of the Holocene Epoch must be understood alongside another transition that is also occurring now, the end of the Cenozoic era, which began approximately 65 million years ago following the extinction of the dinosaurs—the fifth major mass extinction event for life on Earth. Another extinction event is happening now, the sixth mass extinction, and the specific dynamics of the transition out of the Cenozoic and into a new era remain to be determined, depending in significant ways on the activities of humans.

Compelling humans to participate in the Great Work, the story of the universe involves a veritable reinvention of the human, using critical reflection to define humans as a species embedded spatially in the community of life on Earth and temporally in vast evolutionary processes. Moreover, such a reinvention is not simply directed at changing individual humans. It is also a matter of changing the basic institutions of human societies. A transition toward mutually enhancing human-Earth relations demands that governmental, economic, educational, and religious institutions transition toward modes of operation that are more conscious of their ecological and evolutionary contexts. Although much still remains to be done, such institutional transitions are already underway. The nonhuman members of the Earth community are gaining more representation in politics and jurisprudence, such as the recognition of rights of nature in Ecuador's constitution. Economists are determining metrics for more accurately valuing the ecosystem services provided by natural resources, and they are also rethinking ideals of growth and progress. Educational curricula and pedagogy are becoming more inclusive of environmental studies and outdoor learning. Faith communities and religious leaders are exhibiting environmental concern and mobilizing support for more just and sustainable relationships with the natural world. This is not to say that the scientific perspectives of cosmology and ecology should be imposed on these various social institutions. Presenting cosmology and ecology in terms of a story makes it possible to avoid any rigid border separating science from society. Social institutions are themselves active participants in the story of the universe, and thus their perspectives are valuable in themselves. Social institutions interact with sciences, and the universe story provides a common reference point from which hospitable dialog between their various perspectives can promote mutually enhancing human-Earth relations. The perspectives articulated in the sciences provide one aspect of the kind of wisdom included in the story of the universe. For Berry (1999, p. 176), the new story involves "a fourfold wisdom," which includes contemporary scientific inquiry along with the religious and philosophical traditions of classical civilizations, the traditional ecological knowledge and lifeways of indigenous peoples, and the perspectives of women. While people of all sexes and genders are included in the first three parts of this fourfold (science, classical traditions, and indigenous lifeways), Berry recognizes the need to explicitly include the wisdom of women, which has been systematically excluded or suppressed in patriarchal societies for thousands of years.

While there are surely other ways to enumerate the diverse perspectives included in the new story, Berry's articulation of a fourfold wisdom indicates that this story does not privilege any single perspective as being the best or truest. An integrative story must bring traditional and contemporary perspectives into dialog. Along those lines, two students of Berry, Mary Evelyn Tucker and John Grim, took up his work in contributing to the development of an interdisciplinary field of religion and ecology (Grim and Tucker, 2014). The explicit development of this field began in the 1990s with a series of conferences at the Center for the Study of World Religions (CSWR) at Harvard University. Those conferences focused on the cosmological and ecological implications of major religious traditions (Christianity, Judaism, Islam, Hinduism, Buddhism, Jainism, Confucianism, Daoism, Shinto, and indigenous traditions), and one conference focused on the study of animals across religious, ethical, and scientific perspectives. The conferences led to the publication of a corresponding book series, and it facilitated the establishment of the Forum on Religion

and Ecology (FORE). Currently stationed at Yale, the Forum is comprised of a diverse and international network of scholars, researchers, religious practitioners, and advocates. The Forum website is a hub for news, education, research, and outreach in the field of religion and ecology and in intersecting disciplines of ethics, economics, and gender studies. Furthermore, since it began, the Forum has been supportive of the Earth Charter, which is an international declaration of shared values for a global society that is grounded in evolutionary and ecological principles oriented toward the development of a peaceful, just, and sustainable civilization.

Extending their work with cosmological and ecological perspectives, Tucker (co-founder of the Forum) and Swimme (co-author of *The Universe Story*) collaborated with one another on the *Journey of the Universe* project, which includes a documentary film, a book, a series of filmed conversations with experts, a website, and educational curricula. This multimedia project conveys the groundbreaking discovery of the evolutionary story, from the Big Bang through the evolution of life to the present confluence of multiple ecological crises, which mark the transition out of the Holocene Epoch and, on a larger scale, out of the Cenozoic Era. It presents scientific information while also indicating the profound implications that this story has for human thinking, feeling, and acting. This is not to say that *Journey of the Universe* presents itself as an ultimate authority or a guide for civilization. Rather, guidance in the Anthropocene does not come from the *Journey of the Universe* project, Berry's new story, or any other presentation of an evolutionary epic or an integrative vision of human and natural history (e.g., Big History). Guidance comes from the cosmologically and ecologically sensitive wonder that those accounts of the evolutionary journey can evoke or inspire. Wonder challenges assumptions and opens up new possibilities. "This sense of wonder is one of our most valuable guides on this ongoing journey into our future as full human beings" (Swimme and Tucker, 2011, p. 113). This appreciation of wonder is not unlike Berry's fourfold wisdom, which indicates that there is no single perspective that functions as the primary guide for human-Earth relations.

Cosmopolitics

There are multiple ways of opening up to a more conscious and conscientious engagements in one's ecological and cosmological contexts. There are many sources of wisdom, many sources of guidance for understanding and responding to human-Earth relations in the Anthropocene. The complicated challenge of coordinating human-Earth relations into a just and sustainable planetary civilization is the focus of cosmopolitics. This is different from the idea of cosmopolitanism, which began in ancient Greece with philosophers who identified themselves as citizens (*polites*) of the world (*kosmos*). Cynic and Stoic philosophers spoke of cosmopolitanism both to indicate their freedom from the narrow limits of their homeland and to affirm their participation in a larger political milieu. In modern thought, the German philosopher Immanuel Kant proposed a version of cosmopolitanism oriented around a law of universal hospitality that would secure unending peace between all humans. While those ancient and modern senses of cosmopolitanism are useful for expanding politics from local to international scales, they are predominantly anthropocentric, focusing only on human participation in the political collective. However, with the entanglement of human and Earth systems, the conditions of the Anthropocene render untenable any rigid boundary that would separate a human realm of politics from the nonhuman constituents of the natural world.

Reflecting on the entanglement of human and natural systems, the Belgian philosopher of science Isabelle Stengers (2010) distinguishes cosmopolitics from the anthropocentric models of cosmopolitanism. The idea of cosmopolitics suggests that the limit of political activity is extended beyond the human species to the whole cosmos. Politics is thus not an exclusively human activity but takes place in an ecology of diverse practices for composing a shared world, in which practices that represent human interests are interconnected with practices that represent nonhuman interests. Cosmopolitics is thus an integrative approach to navigating the diverse and discordant milieu of knowledge, including traditional and contemporary ways of representing humans and nonhumans. The cosmos is not a background on which a political collective is composed. The cosmos is the unknown possibility of a collective composed of numerous and diverse modes of existence.

From its smallest to largest scales, from its earliest beginnings to the most contemporary events and developments, the cosmos is so immense and dynamic that cosmopolitics will never be finished. Cosmopolitics involves the ongoing composition of a collective in the making. Cosmopolitics resists war not by seeking, like Kant, a perpetual peace grounded in cosmopolitan law, but by maintaining the perpetual struggle of including more modes of existence in the political collective. Diverse entities like rivers, radioactive waste, carbon dioxide, forests, and salmon cannot be neatly separated from human activities, and they are not simply objects of scientific research. Woven into the dynamics of planetary coexistence, they must be engaged politically, as constituents of a planetary civilization. Crucial to the task of representing diverse modes of existence is resistance to any final authority that would impose itself on the ecology of practices and thus circumvent the ongoing work of composing a collective that represents multiple perspectives.

Different discourses can align with and endorse but should not impose the knowledge disclosed through their practices. For example, scientists can endorse knowledge of climate change that is disclosed through practices of Earth systems science, but scientists would circumvent politics if they imposed that knowledge on other knowledges, such as those disclosed in economic, ethical, or artistic practices, or the practices of traditional cultures. Understanding and responding to climate change is severely impeded when science circumvents the political process, and it is likewise severely impeded by politics that fail to represent scientific knowledges. Sciences are necessary but not sufficient for composing a planetary collective. Furthermore, in contrast to secular politics for which religion should be a private matter excluded from the public sphere, cosmopolitics takes seriously the perspectives of religious traditions and faith communities. For example, as climate change is a problem involving energy use (fossil

fuels), representations of the climate must include ecological understandings of energy as well as understandings of cosmic energy (e.g., the Cosmic Microwave Background) and religious conceptions of energy, such as theological notions of God as energy or East Asian notions of a spiritual force or energy (*qi*) permeating all things (Bowman and Crockett, 2012).

Like Berry's new story, cosmopolitics proposes a radical redistribution of agency to all humans and nonhumans. This complicates the binary system that has defined the operations of modern politics, that is, the system for which there is a realm of humans (subjects, society, values, culture) opposed to a realm of nonhumans (objects, science, facts, nature). From the standpoint of cosmopolitics, ecological crises are not simply problems in nature or the environment as opposed to culture or society. Ecological crises entangle humans and nonhumans in complex assemblages and collective histories, which render untenable the modern separation of nature from culture and facts from values. Practices of ethics, economics, esthetics, and religions have contributed to and increasingly are being affected by problems like species extinction, freshwater scarcity, pollution, toxins, and anthropogenic climate change. All theories and facts are value-laden, involving features such as human decisions, scientific instruments, institutional support, and funding. Cosmopolitics engages in diverse distributions of agency while recognizing that there is no nature separate from culture, no objects separate from subjectivity, and no facts devoid of values. It is a craft for composing a common world among multifarious actors across multiple scales, providing possibilities for the participation of humans alongside nonhuman participants, whether subatomic particles and molecules, organisms and ecosystems, technologies and media, or stars and galaxies. Moreover, after thorough representation, not all participants make it into the collective, as some actors have deleterious effects on the collective. For example, while it benefits humans and many other species to represent the global climate as a political actor rather than excluding it from political consideration, it could benefit the cosmopolitical collective to exclude harmful or risky technologies, like certain nuclear reactors or genetically modified organisms.

Particularly important for the Anthropocene is the challenge of representing the planet Earth in the political collective, specifically insofar as the planet is currently being shaped by human impacts. The planet cannot be excluded from the public lives of human beings, as it provides the basic conditions for those lives, and those lives are currently altering its basic systems of life, land, air, and water. The French anthropologist and philosopher Bruno Latour is an example of an advocate of cosmopolitics who is engaged in the task of facilitating the entrance of Earth into a political collective of humans and nonhumans. For Latour (2017), the complex assemblage of human-Earth relations is not simply Earth or a planet, for those designations connote a natural world unaltered by humans. In the Anthropocene, a designation that captures the entanglement of humans with Earth systems is Gaia. Latour is adapting this name from the Gaia hypothesis (also called Gaia theory), which was developed by James Lovelock and Lynn Margulis, who used this name of an ancient Greek goddess of Earth to convey the complex, self-organizing dynamics of Earth systems. While contemporary scientists have expanded this theoretical model into the theories and methods of Earth systems science, the name Gaia is still significant as it indicates that Earth is not just a thing or an object, but is an actor, an agent actively intruding on the political task of composing a common world.

Representing Gaia is not something that scientists can do alone. Art, religion, ethics, law, education, and all aspects of human endeavor have important contributions to make toward a representation of Gaia. In that sense, Gaia is not a totality but an open-ended multiplicity, including contrasting articulations of the multiple modes of existence entangled in human-Earth relations. This is not unlike Berry's new story, for which the single story of the universe is not an overarching totality. Its singularity emerges in an ongoing communion of all the specific stories of material, living, and human beings participating in the evolutionary journey. The task of composing an integrated Earth community is thus a task of representing the diverse Earth stories of humans and nonhumans. Furthermore, Earth stories are not restricted to beings currently on Earth. As a source of energy for Earth, the sun too has a role to play in the cosmopolitical collective, as evidenced by the rising industry of solar energy and the crucial role of photosynthesis for life on Earth. The search for extraterrestrial intelligence and speculations about the colonization of mars are further indications of the interplanetary and intergalactic scope of the actors relevant to cosmopolitics. The challenge of representing Earth stories and cultivating mutually enhancing human-Earth relations has an immense scope, reaching back almost 14 billion years and extending to 2 trillion galaxies. The intimate connection of human existence to that immensity can inspire wonder, guiding humans into new possibilities for planetary coexistence in the Anthropocene.

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