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[1] THERE HAVE BEEN frequent attempts to draw distinctions between *environmentalism* as an umbrella term for a series of interrelated, usually reform-liberal political movements and *ecology* as an ostensibly neutral field of scientific inquiry concerning the web of relations and interconnections between organisms and their environments.

[1.1] In practice, however, such distinctions have tended to collapse in the face of the overawing ecological crises with which humanity has been confronted in the late twentieth- and early twenty-first centuries. Ecological apprehension of late capitalism in the contemporary moment is far from politically neutral, and tends in a contemporary context to be rather fiercely anticapitalist, in ways that frequently go significantly beyond liberal reformism. (Indeed, the use of "ecology" and "ecological" by humanities scholars on the left to describe their own work has typically denoted a deliberate attempt to *go beyond* "mere" environmentalism, in the name of something more radical.)

[1.2] "The realms of ecology and capitalism are opposed to each other—not in every instance but in their interactions as a whole," John Bellamy Foster writes in *Ecology Against Capitalism* (7). In an earlier work, *The Vulnerable Planet*, Foster points to the "four laws of ecology" as proposed by Barry Commoner in *The Closing Circle* in 1971, as a means of distilling the ecological worldview into its core elements:

> 1. Everything is connected to everything else.
> 2. Everything must go somewhere.
> 3. Nature knows best.
> 4. There is no such thing as a "free lunch." (118)

Foster's proposed "four laws of capital," in turn, suggests the extent to which ecology and capitalism necessarily find themselves in inevitable and irresolvable conflict:

> 1. The only lasting connection between things is the cash nexus;
> 2. It doesn't matter where something goes as long as it re-enters the circuit of capital;
> 3. The self-regulating market knows best;
> 4. Nature's bounty is a free gift to the property owner. (120)

In this use of the word "ecology," it is intended to suggest *as a matter of scientific determination* that no environmentalist reform of capitalism is or could ever be viable, and that a new economic order will be required for genuine sustainability; this proposed social system is what Foster and others call *ecosocialism*, or what Kim Stanley Robinson (borrowing a term from agriculture) has called *permaculture* (see "Comparative Planetology"). In both cases, the proposed alternative system is to be one that does not degrade or undermine the conditions for its own continuation, as both industrial and agricultural systems do under capitalism; as Robinson puts this proposition elsewhere:

> Justice becomes a survival technology. […] Real justice would alleviate the poverty that has desperate people stripping away forests and soil in much of the world, and it would reduce the hyper-consumption of the rich, which is equally or even more destructive of resources and excessive in carbon burn. The only possible road to sustainability's necessary carbon neutrality involves justice. (Canavan, Klarr, and Vu 213).

[1.3] For this reason, ecological knowledge is often understood to logically entail anticapitalism by making visible what K. William Kapp once called capitalism's "economy of unpaid costs" (231). "To call for capitalism to pay its way"—to demand, that is, that capitalism take into full account the natural world from which it draws its resources and into which it dumps its by-products and refuse—is "to call for the abolition of capitalism" altogether (Moore 145).

[1.4] However, even this easy equation between ecology and leftist politics must ultimately come under some revaluation, with regard both to anticapitalist or *anti*-Western political movements that are only superficially or opportunistically "ecological"—or, indeed, fully anti-ecological in their political agenda—as well as recognition of the various ways that the property rights that undergird Western cap-

italism have sometimes led to *greater* conservation and environmental protection than would have been possible in their absence. As will be discussed below, the ecological history of human civilization does not necessarily yield simplistic or unidirectional political conclusions.

[1.5] From this perspective, however, we *can* certainly say that all ecology is in *some* sense political ecology, in terms of its application to real-world situations and cultural institutions; in practice ecology necessarily implies some evaluation of human social relations as either ecologically salutary / sustainable / rational / desirable or else destructive / irrational / unsustainable / undesirable. But neither the right nor the left should be understood to have some total or undisputed claim on the political implications of ecological thought.

[1.6] In what follows I will primarily be discussing ecology as a scientific phenomenon with political, cultural, and literary-aesthetic implications. I hope this piece will serve as a useful companion to similar "101" pieces that have run in this space, perhaps most directly Eric C. Otto's "Environmentalism 101" (also available in the eBook *SF 101: A Guide to Teaching and Studying Science Fiction*.) While some overlap is unavoidable, I have endeavored to focus here less on political movements and more on ecological science's use within humanities discourses as a cognitive standpoint that highlights the (at times quite troubled) interconnections between organisms (especially human beings) and their environments, especially as that standpoint manifests within contemporary SF.

[2] The term "ecology" was coined (as *Ökologie*) by Ernst Haeckel in 1866, drawing together the Greek roots for "house" and "study"—the etymological origins thus again suggests the tension between "ecology" as a pure science and "ecology" as a theory of best practices for domestic management, whether that management reflects the unconscious, automatic consequences of evolved animal behaviors or the deliberate intervention of human actors (which, again, are to be evaluated as either adaptive or maladaptive for the various organisms involved).

[2.1] Now another strong internal tension within the idea of ecology becomes visible as well: ecology is at one and the same time the principle of mastery that allows agents in an ecological system to control that system *and* the principle of hard limit that constrains mastery and makes impossible certain levels and types of growth within systems.

[2.2] As Richard Grove shows in his 1995 *Green Imperialism*, however, it would be incorrect to say that ecology only emerges as a concern this late in history. In fact, many of the intellectual developments we now associate with ecology actually have their origins in European imperialism, as Europeans in settler colonies in the tropics frequently attempted scientific management of and intervention within their environs in the name of creating viable and sustainable colonies. Grove notes that much environmentalist rhetoric has its origins in these kinds of colonized spaces, a noteworthy and unacknowledged case of the "periphery" influencing the "center." He also traces the importance of the spatial topoi of *the garden* and of *the island* to early ecological thought, as well as the devastation that the imperialists often brought with them to these island through improper management and invasive species, which ultimately came to premediate a fully *global* devastation that is yet to come but seems to us, today, to be always just around the corner. But Grove also destabilizes the familiar postcolonial narrative of villains and victims by noting that the imperialists were sometimes *more* ecologically "rational" than native groups, and that the legal absolutism of the imperial state often unsettlingly allowed for conservationist policies in the colonial sphere that were possible neither under the precolonial status quo of the Global South nor under the entrenched free markets of Europe.

[2.3] David Mazel's tour-de-force chapter "American Literary Environmentalism as Domestic Orientalism" in *The Ecocriticism Reader* (1996) similarly demonstrates the difficulty of disentangling the desire for ecology as a neutral ground from the ideological construction of terms like "wilderness" that are always embedded in political and historical assumptions about property rights, utilitarianism, white settlement, gender, and the state. Just as Mazel notes that environmentalism is always both resistance to power and the exercise of it, so too we have already seen it is with ecology, which is always both a tallying of mankind's crimes against the environment as well as, precisely through that tallying, the blueprint for continued human domination over the planet.

[2.4] As David Harvey has warned the Left in such works as *The Enigma of Capital* (2011) and elsewhere, anticapitalists neglect the "blueprint" component of ecology's relationship with capitalism to

their peril, as capitalist innovation has repeatedly turned seemingly impenetrable *limits* into mere *boundaries* to be leaped. Perhaps the most emblematic recent case is the discourse around Peak Oil, which for a time in the early 2000s seemed to be an indisputable, silver-bullet argument against capitalist sustainability but which has now utterly vanished as a salient political argument in the face of improved oil sand, oil shale, and deep-sea drilling efficiencies that now seem to promise enough oil to last beyond any of our lifetimes. That these new oil-extraction technologies are themselves *incredibly* ecologically destructive to any lifeforms living nearby has been a relatively small component of the quasi-utilitarian calculus governing their use, not nearly enough to prohibit their development and spread across North America and, increasingly, around the world. Indeed, in many cases an ecological claim has been made on the side of the hydrofrackers, to argue the technology is not only mostly safe but less globally and climatologically harmful than a turn to coal would be.

[3] While ecology was an increasingly important field of scientific inquiry in the early twentieth century, it was the 1962 publication of Rachel Carson's anti-pesticide *Silent Spring* that catapulted ecology to the forefront of public consciousness in the industrial West, as well as launched the environmentalist political movements that would frequently draw on scientific ecological analysis as evidence and as polemic. Carson's text is an exemplary one in many regards, not least of all for its demonstration of the link between ecology (as a means of thinking about the interdependent flows between organisms that sustain life) and *futurity* through her frequent invocations of the bad future that contemporaneous social and agricultural practices were bringing about. "How could intelligent beings," she asks, "seek to control a few unwanted species by a method that contaminated the entire environment and brought the threat of disease and death even to their own kind? Yet this is precisely what we have done" (8-9). Ecology's focus on evolutionary processes, feedback loops, and tipping points necessarily produces a temporality that—especially in our time—suggests the possibility of radically apocalyptic, even extinctive change if ecological cycles become disrupted, distorted, or destabilized. In the late twentieth century an ecological mindset has thus been closely linked to notions of apocalyptic futurity: once-stable (or stable-appearing) systems crashing, collapsing, being thrown out of whack.

[3.1] This observation returns us to Foster's observations about the inevitable relationship between ecology and anti-capitalism, a relationship that can be traced back to Marx's horror in *Capital*, Vol. 1 at the "metabolic rifts" produced by capitalist industrial and agricultural practices. Marx's analysis of agriculture in *Capital* is an early articulation of the negative ecological futurity that now dominates ecological analysis of the future: "All progress in capitalistic agriculture is a progress in the art, not only of robbing the labourer, but of robbing the soil; all progress in increasing the fertility of the soil for a given time is a progress towards ruining the lasting sources of that fertility" (638). As Foster himself shows in *Marx's Ecology*, Marx derived his appreciation of this ecological crisis in the making from the work of Justus von Liebig, whose work in soil ecology led to the development of chemical fertilizers to artificially replenish the soil—a practice of scientific management necessary for the continuation of agriculture at the time but which, in two hundreds of years since, has now contributed to the destabilization of the entire planet's nitrogen cycle. And the nitrogen cycle is only one of any number of ecological stabilities that industrialization and global capital have disrupted, the most famous of which is surely the carbon cycle that is now producing rapid anthropogenic climate change.

[3.2] Traditionally, the environment was been viewed as a potentially hazardous space of danger that was to be transformed, through settlement, into empty, homogenous space for use by human beings—especially in white-settler colonies like the United States that have been so structured by the ideology of the frontier. The rise of ecology as a scientific category inverts this ideological formulation: now the environment is not cultivated and made useful by settlement, but is rather destroyed by its settlement. Rather than a threat that must be tamed by being brought into the flows of human commerce, the environment is primarily seen today as that which is threatened by capital, in need of whatever partial or fitful protection is possible from it.

[3.3] At the same time, ecology is understood to represent a final limit point past which technocapitalist modernity cannot transcend: it is the thing to which capitalism is ultimately and finally subject. Thus, ecology represents a key figuration in our theorization of capital at all stages: the beginning of

capital (in the primitive accumulation of early settlement or frontier life), the middle stage of capital (in the conflict between expansion and conservation), and the end stage of capitalism (as mounting ecological pressures force the system to either significantly reform or else finally collapse).

[4] As much of the examples thus far discussed have suggested, ecology as a discourse (especially in the hands of nonexperts, like ecocritics in the humanities) can be rhetorically hard to disentangle from closely held Romantic and frequently quite moralistic assumptions about the beauty of nature, and about the supremacy of the natural world over either human artifice or social institutions. Nature is taken to be the ultimate source of value—almost a replacement for God—as well as the guarantor of sustainability and stability. Nature is posed as a place of harmony, unity, and balance that human beings degrade, disrupt, and ruin—in almost theological terms. Human beings oppose nature, the suggestion would consequently be, to their great peril; nature is thereby ideological posed both as what is threatened by mankind but also what will soon rise up and punish a mankind who has failed to heed its warnings.

[4.1] James Hansen's famous "Gaia hypothesis" sees this sort of poetic valorization raised to the level of scientific proposition, wherein the entire planet itself is refashioned as a kind of homeostatic, self-regulating superorganism currently fighting off a very bad cancer (humanity). The radical political movement often called *deep ecology* suggests a revision of our social and technological behaviors so as to minimize any and all deviation from that natural harmony, at times teetering on the edge of out-and-out misanthropy.

[4.2] As Dana Philips argues in *The Truth of Ecology* (2003), these formulations are often predicated on a transcendent vision of the Earth as a unified totality that is actually significantly out of sync with the last fifty to a hundred years of practiced ecological science. In fact, our attraction to such values as harmony and balance (and our desire to use them as weapons in a political fight) bears little or no relationship to actual ecologies on this planet, which are far less stable, self-regulating, or well-ordered than the typical "bumper sticker" use of environmental metaphors in politics and culture would seem to allow; in fact ecological niches (a term itself that misleadingly suggests a relationship of "perfected fittedness" between organism and environment that cannot really be supported by how actual ecologies work) are highly unstable, and prone to rapid change and catastrophic collapse.

[4.3] A similar intellectual moment has been underway in a recent strain of ecocriticism frequently called "dark ecology," which rejects literary ecocriticism's fondness for harmony and unity in favor of the strange, the ugly, the ironic, and the grotesque. The figure most closely associated with this movement is Timothy Morton, whose work since his influential *Ecology without Nature* (2007) has been devoted to articulating a vision of ecology that is distinct from the old, no-longer-workable notion of "Nature" as an immanent and stable totality. This ecology is multiple, unknowable, never fully traceable in human terms—more at home with squids and cave lichen than with the attractive charismatic megafauna we typically associate with environmentalist conservation and preservation movements. This formulation at times almost seems to put ecology someplace beyond politics altogether, somewhere in the realm of Goth, punk-rock, or emo aesthetics instead.

[4.4] When this line of philosophical speculation returns, in the end, to the realm of the political, as it does in Morton's later *Hyperobjects* (2013), it is ecology in the mode of radical unknowability rather than scientific certainty—structures (like the climate, or capitalism) so "massively distributed in time and space relative to humans" that we are barely able to cognize them at all. In Steven Shaviro's own appropriation of the term, SF actually becomes one of the best tools available for attempting to partially, incompletely think such hyperobjects: a "psycho-socio-technological cartography" that "traces our place alongside, and within, these hyperobjects that threaten to overwhelm us" (4).

[5] Still, the major uses of ecology in SF have reflected a more down-to-earth sense of futurity that is both more reductionistic and more concretely political, and traditionally both apocalyptic and anticapitalist. The major texts in the eco-apocalyptic genre—ranging from a complex, polyvocal work like John Brunner's wonderfully horrifying novel *The Sheep Look Up* (1972), modeled on John Dos Passos's USA Trilogy, or Margaret Atwood's Oryx and Crake series (2003-2013) and Paolo Bacigalupi's *The Wind-Up Girl* (2009) and *The Water Knife* (2015) to pulpy big-screen thrillers like *Silent Running* (1972), *Soylent Green* (1973), *The Day after Tomor-*

row (2004) and *Snowpiercer* (2013)—have tended to understand the ecological in almost exclusively negative terms. Drawing freely from the tropes of post-nuclear and post-plague scenarios now almost two centuries old— see Mary Shelley's *The Last Man*, from 1826—apocalyptic ecological critique is now so familiarized and habitual that nearly all contemporary science fiction falls under its general aegis, including such radically non-ecological narratives as *The Walking Dead* (comic 2003-, TV 2010-) and *World War Z* (book 2006, film 2013), which are typically read in ecological terms (epidemic; invasive species; the symbiotic relationship between predator and prey; the view from human extinction and "the world without us"), even though the zombic "ecologies" they posit are purely fantastic.

[5.1] Undoubtedly this sense of the ecological as inherently or inimically negative has something to do with the larger history of science fiction, which in its more optimistic flavors (especially in its Golden Age) has itself been a largely anti-ecological genre, imaging fantastic technological devices like zero-point-energy engines, replicators, and perfect-efficiency recycling machines precisely in order to "get around" the constraints that the ecological poses. This *Star Trek*—or perhaps, more directly, *Jetsons*—future encounters the ecological as an unwelcome interruption of what is attractive about futurological fantasy in the first place—as in the seventh-season *Star Trek: The Next Generation* episode "Force of Nature" (1993), where the crew discovers that the warp drive on which the entire Federation (and the interior narrative logic of the entire franchise) depends is actually tearing apart the very fabric of space. (The solution is the imposition of a Warp-Five speed limit in the name of spacetime preservation which is, itself, hastily abandoned by the time *Star Trek: Voyager* premieres just a few years later.) This need to deploy some "ecological cheat" to get around the unhappy facts that would otherwise taint the fantasy become especially necessary in the case of extraplanetary colonization, to be discussed below.

[5.2] The sense that ecology might "ruin the future" was, interestingly, also the mood with which environmental propositions were originally received by many leftist political movements during the moment of their earliest articulation in the political mainstream in the 1960s and 1970s. Despite my above remarks about the seemingly natural affinity between ecology and anti-capitalism, in fact the application of limit (especially environmental limit) to socialist and leftist critique was quite delayed. As Donald Sassoon notes in *One Hundred Years of Socialism*, the early Greens were generally conservative, and that rhetoric around limits and "zero growth economics" appeared very reactionary at the time of the 1973-1974 oil shock, when the collapse of growth rates meant widespread unemployment and suffering especially in traditional left constituencies like industrial workers. Sassoon notes that the 22nd congress of the PCF "explicitly rejected" the idea of zero growth economics, as it was seen as "preparing for a future of penury and restrictions"; its president, George Marchais, said that "growth is necessary to meet the requirements of social and national progress" (qtd. in Sassoon 676)—suggesting again that an optimistic, progressive futurology and ecological reasoning are somehow fundamentally incompatible.

[5.3] Indeed, as Hans Magnus Enzensberger suggests in his 1974 "Critique of Political Ecology," there is a sense in which ecological thinking has tended to be specifically repurposed, or misappropriated, for the purposes of conservativism and reaction (as in many ecological readings of J.R.R. Tolkien's legendarium); as Enzensberger writes, "The bourgeoisie can conceive of its own imminent collapse only as the end of the world. In so far as it sees any salvation at all, it sees it only in the past" (17). Enzensberger juxtaposes the neo-Malthusian arguments of people like Paul Ehrlich in *The Population Bomb* (1968) with the anti-limit, optimistic futurology of Fidel Castro:

> In certain countries they are saying that only birth control provides a solution to the problem. Only capitalists, the exploiters, can speak like that; for no one who is conscious of what man can achieve with the help of technology and science will wish to set a limit to the number of human beings who can live on the earth . . . That is the deep conviction of all revolutionaries. What characterized Malthus in his time and the neo-Malthusians in our time is their pessimism, their lack of trust in the future destiny of man. That alone is the reason why revolutionaries can never be Malthusians. *We shall never be too numerous* however many of us there are, if only we all together place our efforts and our intelligence at the service of mankind, a mankind

> which will be freed from the exploitation of man by man.

[5.4] Reactionary fear of overpopulation, ecological devastation, and competition over energy sources—of a future in which the fantastic economic and technological growth that characterized postwar prosperity becomes impossible—is everywhere we look in science fiction from the 1970s and after. I have already mentioned *Soylent Green*; we can think here just as easily of *Logan's Run*, which maintains a glittering palace of technoutopian futurity at the cost of universal suicide the day you turn 21. In Larry Niven's novel *The Mote in God's Eye* (1974) the logic of overpopulation is transformed into the society of the Moties, who (without any biological ability to check their reproduction) endlessly repeat a cycle of civilization, overreach, crisis, and collapse. In Isaac Asimov's *The Gods Themselves* the energy crisis is solved by the invention of a miraculous solar "pump" that would be the perfect green energy source if only it weren't leeching its free energy from the universe next door. I have suggested elsewhere that even cyberpunk should be read as a kind of reactive backlash to ecological thinking, insofar as the rapid 1980s relocation of the object of SF desire to a place inside the computer can itself be read as an attempt to circumvent the "reality principle" of ecological scarcity by positing an interior cybernetic world where such limits no longer apply.

[5.5] To the extent that twentieth-century science fiction historically imagined a radically unlimited, techno-optimistic future of Promethean world-transformation—provided we don't, say, nuke ourselves in the meantime—ecological science has therefore tended to function not as a licensor or guarantor, but as its bad conscience.

[6] Despite this seemingly antagonistic relationship, however, science fictional thought experiments have quite commonly often been deployed in the other direction, in the service of ecological polemic. Not long ago, for instance, SF author Charles Stross posed a simple question to the readers of his blog, "Charlie's Diary":

> You, and a quarter of a million other folks, have embarked on a 1000-year voyage aboard a hollowed-out asteroid. What sort of governance and society do you think would be most comfortable, not to mention likely to survive the trip without civil war, famine, and reigns of terror?

We can recognize the central problematic of this thought experiment as *sustainability*, in two senses: first, the need for a renewable material environment within which the limited resources available to the asteroid at the start of the journey could recycle, remaining available to humans as the voyage continued; and second the need for a sustainable *cultural form*, an ideology in the Althusserian sense, that could survive and *reproduce itself* within those techno-natural constraints. In the first case, we might say, we need a natural ecology, and in the second we need a political one. And so it wasn't very long before the commentators figured out Stross's punchline: we are *already*, alas, in precisely this situation, only we live *atop* our planetoid and not inside it.

[6.1] The notion that the Earth can itself be thought of as a vast "spaceship" long predates the immense geodesic dome at the center of Disney's Epcot Center (that theme park's most famous, most iconic structure). Perhaps the earliest reference is Herman Melville's *Moby Dick*, in which Ahab speaks of a "frigate earth" that "in her murderous hold … is ballasted with bones of millions of the drowned" (249). In Henry George's *Progress and Poverty* (1879), where the "ship" is imagined as a sea-faring galleon:

> It is a well-provisioned ship, this on which we sail through space. If the bread and beef above decks seem to grow scarce, we but open a hatch and there is a new supply, of which before we never dreamed. And very great command over the services of others comes to those who as the hatches are opened are permitted to say, "This is mine!" (243)

The best known reference today (outside Epcot) may be R. Buckminster Fuller's *Operating Manual for Spaceship Earth* (1968), which ecologically invites us to reimagine the spaceship/planet as "an integrally-designed machine which to be persistently successful must be comprehended and serviced in total" (52). (Contrast Fuller's biopolitical vision with James Lovelock's similarly totalizing Gaia hypothesis, in which the Earth is a machinic superorganism that homeostatically services *itself*.) For Fuller, as for George, the ship is well provisioned, designed as such so that human beings (originating in igno-

rance) could have sufficient time to learn its operations and proper maintenance:

> I would say that designed into this Spaceship Earth's total wealth was a big safety factor which allowed man to be very ignorant for a long time until he had amassed enough experiences from which to extract progressively the system of generalized principles governing the increases of energy managing advantages over environment. … Objective employment of those generalized principles in rearranging the physical resources of environment seems to be leading to humanity's eventually total success and readiness to cope with far vaster problems of the universe. (54)

[6.2] The quoted reference to the "total wealth" of Earth, however, is purely retrospective; against George's cornicopian nineteenth-century use, the Spaceship Earth metaphor tends in the twentieth century to be associated not with abundance but with scarcity, fragility, and limit. In the next chapter of *Operating Manual*, Fuller notes that

> the abundance of immediately consumable, obviously desirable or utterly essential resources have been sufficient *until now* to allow us to carry on despite our ignorance. Being eventually exhaustible and spoilable, they have been adequate only up to this critical moment. (58, emphasis mine)

From this point forward, then, scarcity prevails, and humanity will require careful planners and holistic thinkers, rationally managing every aspect of shipboard operations, to keep the machine running smoothly.

[6.3] In his essay "The Economics of the Coming Spaceship Earth," published two years before Fuller's *Operating Manual* in 1966, Kenneth E. Boulding (the cofounder of the Society for the Advancement of General Systems Theory) characterizes this "critical moment" as the transition from a "cowboy economy" to a "spaceman economy":

> For the sake of picturesqueness, I am tempted to call the open economy the "cowboy economy," the cowboy being symbolic of the illimitable plains and also associated with reckless, exploitative, romantic, and violent behavior, which is characteristic of open societies. The closed economy of the future might similarly be called the "spaceman" economy, in which the earth has become a single spaceship, without unlimited reservoirs of anything, either for extraction or for pollution, and in which, therefore, man must find his place in a cyclical ecological system which is capable of continuous reproduction of material form even though it cannot escape having inputs of energy. (209)

The echo of Fredrick Jackson Turner's 1893 "frontier thesis" is unmistakable; a once-open, once-free frontier of expansive possibility, which previously drove American history, has now slammed forever shut.

[7] This central insight—an ecological one—makes visible certain contradictions that were programmatically obscured by the "space empire" fantasies so beloved by Golden Age writers of SF. In stark contrast to the untold riches they are imagined to provide, distant space colonies—whether on inhospitable moons or orbiting far-flung planets—are in fact necessarily markers of deep, abiding, and permanent *scarcity*, requiring careful management without any waste of resources for any hope of survival. From an earthbound perspective, the colonization of space appears wildly expansive, a "New Frontier" that opens up the entire universe to human experience and exploitation—but from a perspective *inside* one of these spaceships or colonies, life is a state of fragile and even hellish enclosure, at constant risk of either deadly shortages or deadly exposure to the void outside.

[7.1] Ecology today remains the unhappy visitor, or the poisonous supplement, to any number of familiar contemporary science fictional scenarios as well, but it is perhaps most radically destructive of this fantasy of extraplanetary colonization. The colonization of outer space has frequently presented itself as the perverse *solution* to the discovery that the environment of our planet is under threat from the unknown or unacknowledged by-products of human activity—the idea being that we might be able to bootstrap our civilization into orbit and out into the larger galaxy before the terrestrial environment crashes. But in contemporary works like Kim Stanley Robinson's recent far-reaching novel *Aurora* (2015), that logic reverses itself entirely: we now

know too much about ecology and evolutionary biology to take seriously the idea that we could ever simply go to another planet and just *live* there. Ecology becomes the despoiler of that greatest of science fiction dreams, the conquest of the stars; even if we decide to brave the centuries-long journey to another star, and even if we are lucky enough to find a habitable planet there, we are likely to find ourselves greeted by a counter-ecology with which we cannot biologically interact or co-exist, much less eat or interbreed with. In *Aurora* the toxic particle is as small as a tiny prion, but all the same it renders the new planet utterly uninhabitable to us, in effect dooming our dreams of space altogether.

[7.2] Other recent works about extraterrestrial travel end more happily, though typically with some sour ecological note. In *Interstellar*, the astronaut heroes take advantage of a wormhole and fifth-dimensional time-travel shenanigans to get a viable off-world colony started—but the last shot of the film reveals the settlement as a tiny encampment in an icy hellhole, over which a single American flag stands silent, miserable guard. More typically, however, the heroes' reward at the end of the narrative is to be allowed to return to Earth, to live *here* instead of *there*. *The Martian* sees its titular hero (barely) able to survive being stranded on Mars, hacking together a temporary ecology of oxygen, water, feces, and potatoes that is able to get him *just enough* food, for just long enough to be rescued. His happy ending is that he doesn't have to keep living on Mars, but gets to come home—as the characters do, to one extent or another, in other recent space operas like *Jupiter Ascending*, *Battlestar Galactica*, and *WALL-E*. Space, alas, is no longer the place. Even a nominally techno-optimistic novel like Neal Stephenson's recent *Seveneves* (2015)—ostensibly devoted to proving the indomitability of human ingenuity and creative potential even in the face of the end of the world—posits an incomprehensibly terrible nightmare future in horrid cramped, starvation-ridden satellites in its attempt to argue that we might realistically live anywhere else but Earth.

[7.3] Not that home is looking so great either. If the ecological poisons dreams of escape, it also poisons dreams of our continued survival down here, as witnessed both through the incipient mass extinctions of animal life in the present and, via the prolepsis of the suddenly ubiquitous "Anthropocene," the backwards-looking cognitive standpoint from an inevitable future of human extinction. What the ecological promises in our context is not safe-in-God's-hands reliability or stability, but a world of rapid and radical flux to which life forms must either adapt themselves or die (and most die). In the archive of recent SF, Octavia E. Butler's various space colonization stories—Xenogenesis in the 1980s, the unfinished Parables series of the 1990s, "Amnesty" in the 2000s—may speak most directly to the depressive sense of incipient, irrevocable doom that permeates contemporary life, as well as offer grim visions of the sorts of biological and ecological transformations that (we hope) will be better than the species just dying out entirely. Her characters find a way to adapt, and live, and even grab for themselves tiny pieces of those older, better science-fictional futures that now seem to us to have fallen out of our civilization's grasp—albeit at very great cost.

[7.4] The alternative to the sort of vexed self-transformation we see in Butler, or in something like Margaret Atwood's *Oryx and Crake*, is rather the world of universal death posited by Atwood in her "Time Capsule Found on the Death Planet," written in 2009 alongside the Copenhagen climate talks. Human history, per "Time Capsule," is a progressive history that arrests itself in the final age through the industrious creation of a universal desert, characterized by spaces where nothing grows, until "at last all wells were poisoned, all rivers ran with filth, all seas were dead; there was no land left to grow food." At this point Atwood's unnamed narrator, implied to be the last human alive, turns to the person who will someday find her message:

> You who have come here from some distant world, to this dry lakeshore and this cairn, and to this cylinder of brass, in which on the last day of all our recorded days I place our final words:
> Pray for us, who once, too, thought we could fly.

Here again, as in Butler's and Robinson's later stories, the dream of outer space turns toxic, a narrative for some other, better version of the human race rather than ourselves; our species, we feel, seems somehow to have missed its chance, and fallen into the deep gravitational well of its doomed planetary ecology instead.

[8] Back in the real world, and real human history,

the human species seems at the dawn of the twenty-first century to be at a key inflection point: a moment in which technoindustrial modernity is struggling to even *acknowledge* the problems of climate change, ocean acidification, overfarming, antibiotic-resistant organisms, ubiquitous pollution, and megadrought, even as each of these crises seems to be crossing points-of-no-return. The findings of ecological science and related fields are, in our moment, incredibly urgent and unspeakably dire, and seem to augur a near-term future of deprivation and suffering if not out-and-out mass death and extinction. A five-alarm fire, all our ecological knowledge screams, is now raging on multiple fronts everywhere across the planet—and SF, like so many of our cultural institutions, is still struggling to catch up.

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While a full list of SF novels and short stories dealing with the subject of "ecology" is of course much too overwhelmingly numerous to name here, I would suggest the list generated by Eric Otto in his "Environmentalism 101" piece as a very good starting point, as well as entries like ECOCATASTROPHE, ECOLOGY, and NATURE in Brian Stableford's *Science Fact and Science Fiction: An Encyclopedia* (Routledge, 2006) and the list of works "Of Further Interest" I complied as an appendix to *Green Planets*. Of the novels that have appeared since that publication, I would especially recommend:

Margaret Atwood's *MaddAddam* (2013);
Paolo Bacigalupi's *The Water Knife* (2015);
Liu Cixin's *The Dark Forest* (2015);
Karen Joy Fowler's *We Are All Completely Beside Ourselves* (2013);
William Gibson's *The Peripheral* (2014);
Emily St. John Mandel's *Station Eleven* (2014);
James Patterson's *Zoo* (2012);
Kim Stanley Robinson's *2312* (2012), *Shaman* (2013), and *Aurora* (2015);
Neal Stephenson's *Seveneves* (2015);
Claire Vaye Watkins's *Gold Fame Citrus* (2015); and
Andy Weir's *The Martian* (2011)

as being of particular interest.