
A Tale of Two Systems: Anthropocene Politics, Gaia, and the Cybernetic Image of the Planet

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ABSTRACT

Most discussions of the Anthropocene interpret it as a moment when customary distinctions between nature and culture break down and humans either successfully subsume the Earth under their own purposes or, conversely, abandon the modern project of dominating nature. Both interpretations respond to the cybernetic understanding of the Earth as a self-regulating body proposed by Gaia theory and the Earth system sciences. This essay shows how this idea is parsed differently by representative proponents of these two conflicting views (Hans-Joachim Schellnhuber and Bruno Latour, respectively) and counters them with a third interpretation which builds on Michel Serres's *The Natural Contract*. Serres argues that our historical moment should not be construed in terms of a merger of nature and culture; rather, society and the Earth should be understood as two self-regulating systems that are coupled but remain distinct. Whereas writers like Schellnhuber envision a society that acquires the ability to regulate the Earth system, Serres suggests that the challenge for world society in the Anthropocene is to regulate itself *vis-à-vis* a natural system that also regulates itself.

KEYWORDS cybernetics, Earth system science, Bruno Latour, James E. Lovelock, Lynn Margulis, Hans-Joachim Schellnhuber, Michel Serres

Ex-position, Issue No. 44, December 2020 | National Taiwan University
DOI: 10.6153/EXP.202012_(44).0002

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Ecomodernism and Ecological Posthumanism

The Earth is technically ours. That seems to be the message of the “Anthropocene”—of the new geological epoch that, according to a steadily growing number of scholars from a wide spectrum of disciplines, “our” planet has entered into. Indeed, the entire debate over the Anthropocene in the humanities can be understood as one long argument over the terms of this statement. The Earth is technically ours because this ongoing geological transformation is the cumulative effect of the various ways in which human technology has intervened in the Earth’s biosphere, pedosphere, atmosphere, hydrosphere, and cryosphere—the ways, that is, in which it has changed living things, the Earth’s crust and gaseous mantle, its bodies of water and ice. In all of its dimensions, the Earth now bears the signature of the human species who gives to this new geological age its own name. At the same time, however, it is abundantly clear that human beings are not actually in charge of this process—that the Earth of the Anthropocene is “ours” in name only. Rather than ratifying human efforts to possess the planet, the Anthropocene seems to show that humans belong to the Earth and that they cannot dictate the terms of this belonging.

Interpretations of the Anthropocene have thus tended to cast this geological epoch either as *consummation* or *abandonment* of modernity, if by “modernity” we mean the grand project of establishing the “Empire of Man” over nature, as outlined for example in Francis Bacon’s seminal *Novum Organum* (1620). Either way, the categorical distinction between a human realm and a realm of nature loses its former salience: in the first instance, because the Earth in its entirety would now be subsumed under human ends; in the second, because we have come to understand that this distinction was always a dangerous delusion, a denial of humans’ primordial connectedness to the Earth which the Anthropocene is now again rendering inescapable, and even an ideological ruse justifying the dispossession and subjugation of the Earth’s peoples, human and otherwise, for the exclusive benefit of Bacon’s heirs. The first interpretation of the Anthropocene can be designated as *ecomodernism*, the second as *ecological posthumanism*.¹

These conflicting interpretations engender fundamentally different conceptions of Anthropocene politics. The first view implies that humans need to double down on their efforts to control the natural world, and that the political challenges of the future will have to do with building structures of global governance which

¹ On the distinction between ecomodernism and ecological posthumanism, see Horn and Bergthaller 70-74.

could orchestrate “the purposeful manipulation by humans of global-scale Earth System processes with the intention of counteracting anthropogenically driven environmental change such as greenhouse warming” (Steffen, Crutzen, and McNeill 619). This view is widespread among the “global research and engineering community” to whom Paul Crutzen and Eugene Stoermer addressed their original pitch for the formalization of a new geological epoch (Crutzen and Stoermer 18), but it also hovers in the background when “world leaders” (as they are generally referred to by the news media) congregate at climate summits and proclaim their determination to limit global warming to 2 or 1.5 centigrade, thus projecting the image of a unified humanity confidently seizing the planetary thermostat.

The second view, meanwhile, has prevailed in the environmental humanities, which tend to take their cues in this regard from posthumanist thinkers such as Donna Haraway, Bruno Latour, and Isabelle Stengers. Latour, in particular, has cast the Anthropocene as a vindication of his long-standing contention: *We Have Never Been Modern*. Latour’s central proposition there, as in many of his subsequent publications, was that the categorical distinction between a natural and a social domain is a quintessentially modern invention. Roughly from the seventeenth century onwards, the distinction authorized a bifurcation of discourses which, as he puts it in *Facing Gaia*, “made it possible to deanimate one sector of the world, deemed objective and inert, and to overanimate another sector, deemed to be subjective, conscious, and free” (85). The natural sciences confined themselves to a world of obdurate facts and seamless causal chains, while philosophers, sociologists, and politicians were given license to speak of values and uniquely human aspirations—as long as they accepted the malleability and multifariousness of cultures as evidence of their insubstantiality when set against the singular, hard-edged nature of the sciences. This modern cosmology allowed for a mobilization of non-human entities at a historically unparalleled scale, entangling humans in an ever wider and ever more complex weave of forces, at the very same time when it denied agency to any entity other than the human. What has now brought this strange episode of metaphysical doublethink to a definite close, according to Latour and his intellectual allies, is the “intrusion” of a new actor that upends the nature/culture distinction: Gaia, or the Earth as a composite body which is capable of responding to human action and therefore imposes a new “response-ability” on humans (Latour, *Facing Gaia* 107, 29).²

For all their overt differences, however, there is also a considerable amount of common ground between these two interpretations of the Anthropocene. Both

² Latour’s use of this term here follows that of Donna Haraway in *Staying with the Trouble* (see Haraway 2).

suggest that familiar ways of distinguishing between nature and culture have become obsolete, such that the social and the natural domains become fused in some manner. And both conceive of the hybrid entity that emerges from this fusion in terms that can be traced back to the cybernetic image of the planet first sketched by James E. Lovelock in the late 1960s, in what he came to call the Gaia hypothesis. Indeed, the Gaia hypothesis marked a genuine paradigm shift in our understanding of the Earth that constitutes the epistemic core of the Anthropocene concept. What I aim to do in the following pages is to propose a third interpretation of the Anthropocene, one that hews more closely to the version of Gaia developed by Lovelock's long-time collaborator Lynn Margulis and which aligns itself with a theory of social autopoiesis as it is found in the work of Niklas Luhmann—that is, an interpretation that lays emphasis not on the fusion of the social and the natural, but rather on the operational closure of different systems (organic, social, or metabiotic) as a prerequisite to their co-evolution and ongoing self-maintenance. In order to understand the ways in which human action has become ever more deeply enmeshed with nonhuman forces, we also need to understand how social and natural processes at the same time remain sharply distinct. The general outlines of such a view, I argue, are already to be found in what is arguably the first rigorous attempt to take the philosophical measure of the Anthropocene: Michel Serres's 1992 treatise, *The Natural Contract*.

Planetary Cybernetics: From the Gaia Theory to Earth System Science

Lovelock developed the Gaia hypothesis while freelancing for NASA's Viking mission, one of whose aims was to search for life on Mars. Comparing the Earth with the neighboring planets Mars and Venus, he realized that the composition of the former's atmosphere constituted a profound anomaly: elemental oxygen, for example, is a highly reactive gas. In the normal course of events, it should long have been soaked up by the Earth's crust, entering into chemical compounds with other elements. The high concentration of oxygen, as well as other distinctive features of the Earth's atmosphere, can only be explained by the biochemistry of organic life. Yet these biochemical processes, in turn, are possible only because the composition of the atmosphere has continuously shifted over the course of the Earth's history so as to compensate for the steady increase in solar radiation, such that the planet's surface temperature remained within the narrow range suitable to complex biological organisms. From this, Lovelock concluded that biosphere and atmosphere together function as components of a single homeostatic system—a system whose elements are coupled to each other by feedback

loops which allow it to stabilize itself against the ambient flux.

It is difficult to overstate the radicalism of this shift in perspective. In 1999, Hans-Joachim Schellnhuber described it as nothing less than a “second ‘Copernican’ revolution” which both complemented and in an important sense reversed the first one: whereas Copernicus showed that the Earth was just one planet among many, the Earth system sciences reveal our planet to be “one single, complex, dissipative, dynamic entity” (20). Unique among all the celestial bodies known to us, the Earth possesses an ability otherwise familiar from living organisms: it can compensate for external perturbations so as to maintain itself in a state “far from thermodynamic equilibrium” (20). It is, in other words, not just a big rock in space that happens to have some plants and animals on it, but rather a complex system whose components, biotic and abiotic, modulate each other in such a manner that life has been able to persist for over 3.5 billion years. Life didn’t merely evolve *on* Earth—rather, it *co-evolved with* the abiotic components of the planet (pedosphere, atmosphere, hydrosphere, etc.) which were, from the outset, profoundly shaped by life’s presence.

Significantly, Schellnhuber only mentions Lovelock in passing, as the originator (along with Margulis) of the Earth system sciences’ “romantic companion, Gaia theory” (21). By the time Schellnhuber’s article was published in *Nature*, the Gaia hypothesis had not just graduated to the status of a genuine “theory” (albeit one still easily disparaged as “romantic”). It had, Schellnhuber suggests, also been superseded by the Earth system sciences, a sprawling, multidisciplinary enterprise hatched under the vast institutional canopy of the International Geosphere-Biosphere Project (IGBP). It was the IGBP, initiated in 1987 and concluded in 2015, which marshaled the costly administrative and technological infrastructure necessary in order to flesh out the inspired speculations of Lovelock and Margulis with empirical evidence. Satellites and other kinds of advanced sensing equipment, along with systems of image and data processing, gradually enabled Earth system scientists to trace the complex tangle of feedback loops which underlie Gaia’s ability to self-regulate. This, then, is the cybernetic image of the planet referred to in the title of this essay. It is cybernetic in a double sense. Firstly, as Lovelock himself repeatedly pointed out in *Gaia*, his original schematic of Gaia was deeply informed by the body of research into “circular causal and feedback mechanisms in biological and social systems” that had emerged since the 1940s (von Foerster, Mead, and Teuber). Secondly, this schematic was substantiated with the help of a technological apparatus that developed out of that same cybernetic tradition.

In recent discussions of the Anthropocene, the cybernetic pedigree of the

concept which stands at its center—that of the Earth as a single, self-regulating body—is rarely addressed directly. However, the conflict between ecomodernism and ecological posthumanism which I have sketched in the preceding section is essentially one that concerns the implications of cybernetic thought for our understanding of the relationship between humans and the Earth. Cybernetics grew out of the effort to understand the formal properties of complex, adaptive systems—i.e., systems that are able to respond to changes in their environment in ways that are not entirely determined by the latter. Biological organisms had been known to be capable of this, but rapid advances in engineering during WWII raised hopes that it would be possible to construct machines able to replicate the purposive behavior of living things—and, conversely, to control and engineer living things with the same precision as machines. The program was neatly encapsulated in the subtitle of the book which put the name of this enterprise into general circulation, Norbert Wiener’s seminal *Cybernetics: Or Control and Communication in the Animal and the Machine*. Wiener and his colleagues famously coined the term with reference to the mechanical “governors” used, for example, in steam engines, which were an early instance of the type of feedback system they now sought to identify in other domains, and they invoked the etymological root of the term: in ancient Greek, *kybernetes* refers to the pilot or helmsman of a ship (Wiener 11-12).

When Will Steffen, Paul J. Crutzen, and John R. McNeill write that “humanity is . . . becoming a self-conscious, active agent in the operation of its own life support system” (619), no explicit reference to cybernetics is required in order to call up the image of mankind as the pilot of a “Spaceship Earth”—for which the research of the IGBP is to supply the “manual,” as it were. Buckminster Fuller’s popular application of cybernetic ideas to the ecological problems which were just beginning to capture a broader audience was published in 1963, several years before Lovelock’s early forays into what would become Gaia theory, but it already anticipated the spirit in which the latter was subsequently taken up and reformulated by the Earth system sciences. Unlike Fuller, the Earth system sciences may not be wedded to any sort of Cartesian dualism (Clarke, “Steps” 272), yet their representatives clearly put great stock in human consciousness.³ If they exhort us to think of human society as another element of the Earth system, the elevated role that they have in mind for it is that of a central processing unit, or a central nervous system. Rehearsing one of the animating fantasies of this

³ Crutzen and Steffen were leading researchers in the IGBP; McNeill is one of the grandmasters of environmental history in the United States, but in his work on global environmental history, he has clearly aligned himself with the Earth system sciences.

discourse, Schellnhuber suggests that “global telecommunication” inevitably precipitates a “global subject” (which he notates as *S* in his schematic of the Earth system) that acts on the planet as a “self-conscious control force” (22). Just as the human brain learns to control its body by comparing its output with its input—i.e., via feedback from its proprioceptive sensorium—so this global subject will eventually learn to steer its extended, planetary body:

An ever-evolving Earth-observation system will allow *S* to watch its own footprints on the ecosphere, and Earth-simulation models will enable *S* to make collective “rational choices” on the system’s level. Finally, densely linked global institutions, such as the innumerable worldwide activists’ networks, will help enforce resolutions of *S*, such as those made in international environmental conventions. This is the emergence of a modern “Leviathan,” embodying teledemocracy and putting the seventeenth-century imagination of the English philosopher Thomas Hobbes into the shade. (22)

One may well wonder what compelled Schellnhuber to place “rational choices” in scare quotes here; however, taken as a whole, his *precis* of Earth system science leaves no doubts that it is conceived as a comprehensive art of governance under whose purview the body politic will be made to coincide with the body of the Earth itself. And whatever humility Earth system scientists might otherwise counsel, it is clear that when they speak of control, what they mean is domination.

(Quasi-)Cybernetics in Latour’s *Facing Gaia*

Against this background, it is not surprising that ecological posthumanists regard cybernetics with almost universal suspicion and disdain (see Clarke, *Gaian Systems*). This is especially striking in the case of Bruno Latour. In *Facing Gaia*, Latour casts Lovelock as a latter-day Anti-Galileo. His argument runs exactly parallel to that of Schellnhuber when he speaks of our historical moment as one of “counter-Copernican revolution” (61). In Latour’s telling, Galileo’s discoveries inaugurated the infinitely extended space with which the natural sciences would henceforth be concerned, the ontological theater of modernity. They made it possible to “treat all the planets, all the suns, all the galaxies as so many billiard balls” (77). Conversely, Lovelock demonstrated that the Earth was not just another “body in free fall” that humans can view with detachment (60), but one of a kind—not the center of *the* universe, perhaps, but a “little universe” in its own right (80), one to which humans are inextricably bound. Whereas Galileo

had arrived at a radical homogenization of space by stripping things of all qualities except movement and extension, Lovelock directed our attention to those features of the Earth that set it decisively apart from other planets: “[I]t seems capable of actively maintaining a difference between its inside and its outside. It has something like a skin, an envelope. More oddly still, the blue planet suddenly looks like a long string of historical events, random, specific, and contingent events, as though it were the temporary, fragile result of a geohistory” (78-79).

The features of Gaia that Latour lists here are, of course, precisely the ones that Lovelock himself, and the Earth sciences after him, attributed to its constitution as a homeostatic, cybernetic system: it is the feedback loops connecting atmosphere and biosphere, the oceans and the Earth’s crust, that have enabled the planet to stave off thermodynamic equilibrium, to maintain the balmy conditions (by cosmic standards) which have allowed organic life to flourish. Yet Latour goes to extraordinary lengths to deny this conceptual kinship. “Gaia,” one reads, “is not a cybernetic machine controlled by feedback loops but a series of historical events . . .” (140-41). In a later chapter, Latour seems to be responding directly to Schellnhuber (although he never mentions him by name) when he writes, “Gaia does not possess, must not possess, the legal quality of the *res publica*, of the State, of the great artificial Leviathan invented by Hobbes. *It is from the State as well as from the State of Nature that it comes, as it were, to set us free*” (282). The quote suggests that Latour’s aversion against cybernetics is grounded in political as much as in epistemological or ontological objections. He views cybernetics as the culmination of the modern project of mastering nature, of a totalizing gaze that arrogates all power and agency to the human.

If one hears a certain exasperation in these sentences, it is surely because even while Latour inveighs against cybernetics, he finds himself unable to entirely dispense with its conceptual vocabulary. To become responsive to Gaia, he writes, is to “feel the consequences of your action . . . and become aware of the tenor of the world that has resisted your action” (138). Charles Keeling’s famous calculation of the rising CO₂ content of the atmosphere, the measurements demonstrating the depletion of atmospheric ozone and the models developed to calculate the consequences of a “nuclear winter”—all these are cited as examples of the manner in which “loops” are drawn that connect human actions to their effects on the planet. As Latour puts it, “The slow operation that consists in being enveloped in sensor circuits in the form of loops: this is what is meant by ‘being of this Earth’” (*Facing Gaia* 139). But how, one must ask: Is this really different from the kinds of circular causality explored by classical cybernetics, or from Schellnhuber’s vision of an “ever-evolving Earth-observation system”? What distinguishes Latour’s

“quasi-feedback loops” (*Facing Gaia* 139) from the genuine article? There are passages in *Facing Gaia* where Latour comes close to acknowledging that his own thinking on Gaia may be less a wholesale rejection of planetary cybernetics than a reformulation of it, one that seeks to “tilt” it away from its associations with the domination of nature:

In the very etymology of the word cybernetics, there is a whole government that purports to be holding the tiller! The question is whether the metaphor tilts toward technology, with a proliferation of server commands and control centers, or toward politics, with a proliferation of opportunities to hear protests by those who insist on reacting in response to the commands! On one side, the modern ambition par excellence is extended further and further, all the way to the nightmarish dream of geo-engineering; on the other, the situation is turned to advantage, allowing for demodernization and a return back to Earth. (282)

There is a considerable amount of irony in the fact that in his strenuous efforts to sever Gaia from its cybernetic inheritance, Latour focuses almost entirely on Lovelock’s contributions to Gaia theory, when he could equally well have turned to the work of his collaborator, Lynn Margulis, who was much less invested in the domineering “command and control” version of cybernetics that Latour is so wary of, and whose later development of Gaian thought drew inspiration from a very different strand of cybernetics—one which emphasized autopoiesis over homeostasis, contingency over teleology, and self-organization over hierarchies of control (Clarke, “Margulis”). Even closer to home, he could have found a more humble vision of Gaian cybernetics in a book that he in fact discusses quite extensively, namely Michel Serres’s *The Natural Contract*.

Two Sets of Equilibria: Serres’s *Natural Contract*

The Natural Contract was published in 1992, the same year as the United Nations Framework Convention on Climate Change, and not long after the passage of the Montreal Protocol for the protection of the Earth’s ozone layer (1987). As I have suggested above, it is arguably the first philosophical text to tackle head-on the paradigm shift in our understanding of the Earth that had taken place in the wake of Gaia hypothesis. Although Serres never mentions the IGBP by name, the problem of “global change” which motivated this research project also stands at the center of Serres’s reflections. As the book’s title suggests, Serres is specifi-

cally concerned with the question as to how this new type of knowledge requires us to rethink the foundations of the political order: the natural contract he advocates would supplement the unwritten social contract by which, in the modern understanding, the body politic was constituted.

Nevertheless, *The Natural Contract* has only played a very minor role in recent debates over the Anthropocene. One of the few authors who devote more than a footnote to it is Timothy Clark. In the opening chapter of *Ecocriticism on the Edge* (2015), he introduces Serres's book as an example of "the kind of dangerous fantasy that the Anthropocene may represent" (3). Clark quotes from the closing chapters of *The Natural Contract*, the book's visionary climax, where Serres discusses the famous image of the whole Earth as seen from space and suggests, in Clark's paraphrase, that only from this perspective does it finally become possible to speak "of an achieved humanity in the singular" (3). According to Clark, Serres thus "anticipates . . . contemporary arguments that the Anthropocene, in its very danger, could also represent the hope for a new form of humanism, one tied to a collective self-recognition of the human as 'steward' of the planet, envisaging the Earth as a vast garden-city sustained by various geo-engineering schemes" (4).

Clark is hardly to be faulted for selecting passages from *The Natural Contract* which allow him to set the stage for the central argument of his own book—namely that the Anthropocene plunges into paradox many of our inherited ways of thinking about human agency, culture, and political order. Clark portrays Serres as an ecomodernist, and there is indeed much in *The Natural Contract* that could be cited in support of such a reading. When Serres speaks of "a universal-subject, humanity, in solidarity at last, . . . contemplating the object-universe, Earth" and waxes lyrical about "the sum of our technologies, the collection of our communications . . . , torrents of signals, . . . the complete set of imaginable umbilical cords, living and artificial" which bind the two together (122), the difference from Schellnhuber's speculations about the "global subject" *S* would seem to be primarily one of tone, rather than of substance. And yet, it is precisely in those parts of the book where Serres engages most directly with cybernetics that his thought departs decisively not only from ecomodernist projects of planetary mastery, but also from Latour's program of exiting modernity through a fusion of nature and culture. Here is how Serres lays out the challenge:

There are one or several natural equilibria, described by physical mechanics, thermodynamics, the physiology of organisms, ecology, or systems theory; cultures have even invented one or more human and social equilibria, which are decided on, organized, and maintained by religion, laws, or politics. But

something is missing: we are not conceiving, constructing, or putting into operation a new global equilibrium between the two sets of equilibria. (37)

In the first sentence, Serres gives a quick run-down of several key disciplines which have formed the seedbed of cybernetics since the 1940s. Their description of “natural equilibria” hinges on homeostasis *qua* feedback—and although Serres mentions neither Gaia theory nor the Earth system sciences by name, his understanding of the Earth as “a physical system millions of years old, a system that fluctuates and yet remains relatively stable through rapid, random, and mult-century variations” (30) is clearly based on their conception of the planet as a self-regulating entity. What sets his account here apart from that advanced by Latour is his insistence that culture, too, should be conceived as a self-regulating system or set of systems. This point is driven home in the following passage:

Social systems, which are self-compensating and self-enclosed, press down with their new weight, that of their relations, object-worlds, and activities, on self-compensated natural systems, just as in the past natural systems put social systems at risk, in the age when necessity triumphed over reason’s means. (37)

The challenge, as Serres presents it in these passages, is not for social systems to somehow assimilate natural systems or vice versa. Unlike both the ecomodernists and ecological posthumanists, Serres is not envisioning some kind of merger of nature and culture. He makes it abundantly clear that we are dealing not with *one* system which humanity must bring under its control or, alternatively, contemplate with post-religious awe, but rather with *two* systems (or two systems of systems, two “sets of equilibria”) which are *both* self-regulating, and *which remain distinct*—but which are, at the same time, coupled with each other. This stands in sharp contrast to Latour’s hyphenated earth-bound nature-culture hybrids, but it should not be mistaken as advocating humanity appointing itself helmsman of the planet. Serres is not arguing that society can or should control the Earth system, but rather that *society must regulate itself in light of its dependency on an Earth system that also regulates itself*.

This difference is further clarified if one takes a closer look at one of Serres’s favorite metaphors for the natural contract, namely the sailing ship. What distinguishes life on such a ship from life on land is that there is no possibility to physically withdraw from the company of others. On a ship, nature is not a place one can escape to in order to evade social constraints (as in so much of Romantic and post-Romantic thought); on the contrary, nature imposes constraints which

directly condition social life. As Serres puts it, “on board, social existence never ceases” (40)—and this means that “sailors get their social contract directly from nature” (40). They must regulate their own tempers and keep a lid on internal conflicts if they are to avoid shipwreck. This situation prefigures the one that humanity now finds itself in today, and it represents a radical break with the past:

The social pact of courtesy on the seas is altogether different from the contract by which other human groups organize themselves. . . . [It] is in fact equivalent to what I’m calling a natural contract. Why? Because here the collectivity, if sundered, immediately exposes itself to the destruction of its fragile niche, with no possible recourse or retreat. (40)

So Serres’s natural contract is nothing at all like Fuller’s *Manual for Spaceship Earth*, nor does it map neatly onto conceptions of planetary stewardship or Earth system governance. It is not a matter of humans steering an Earth system that includes them as one of its elements, but rather of steering world society vis-à-vis a natural system that reacts to human actions on its own terms, in ways that human actions cannot control. In his meditations on the ship as a metaphor for the human condition in what we have learned to call the Anthropocene, Serres explicitly invokes the etymological connection to cybernetics, but he does so in a manner that precludes any delusions of unilateral control. The ability of a helmsman to perform his task depends on the feedback loops that tie him to his ship, and his ship to the sea: “His will acts on the vessel, which acts on the obstacle, which acts on his will, in a series of circular interactions” (42). No sane pilot would get it in her head to steer the sea itself; her job is to keep the ship on its appointed route across a sea that she knows perfectly well cannot be controlled.

Neocybernetic Gaia and the Control of Control

For Serres, the discovery that the Earth is a self-regulating system does indeed mean that the dream of mastering nature and making it our own has come to an end. Just like Latour, he associates this dream with modernity, and, again like Latour, he suggests that its ending returns humans to a situation that resembles that in which they found themselves in earlier times: “Even more than we possess [the Earth], it will possess us, just as it did in the past, when old necessity, which submitted us to natural constraints, was still around, but it will possess us differently than back then. Then locally, now globally” (34). Serres plays with an entire panoply of narratives and conceptual figures in order to characterize this

strange new sense of mutual belonging, but the trope he keeps returning to with the greatest insistence is the biological metaphor of parasitism and symbiosis. Ultimately, he suggests, the function of the natural contract will be to transform the relationship between humans and the Earth from the former into the latter. Just as the social contract places limitations on the power of the masters so as to reign in “abusive parasitism among men” (37), so the natural contract is to limit man’s power to dominate and exploit nature: “Why must we now seek to master our mastery? Because, unregulated, exceeding its purpose, counterproductive, pure mastery is turning back on itself. Thus former parasites have to become symbionts; the excesses they committed against their hosts put the parasites in mortal danger, for dead hosts can no longer feed or house them” (34).

Hans-Jörg Rheinberger has argued that Serres’s thinking here follows that of the American biologist Lynn Margulis, whose theory of serial endosymbiosis had ushered in a paradigm shift in evolutionary biology that was no less profound than that provoked by Gaia theory in our understanding of the Earth. Based on her research into the origins of eukaryotic cells, Margulis argued that symbiotic relationships play a far more important role in evolutionary history than classical Darwinism had recognized. Biological species are shaped not only by differentiation, but also by fusion and exchange, such that “Darwin’s principle of ‘divergence’ which dominates his tree of life is symmetrically complemented by a principle of ‘convergence.’ The principle of competition is complemented by that of cooperation, which is evident on every biological level” (Rheinberger 29). This perspective also shaped Margulis’ distinctive take on Gaia theory, which she would lay out in her 1998 book *The Symbiotic Planet: A New Look at Evolution*. The bacterial precursors that become the mitochondria and chloroplasts of eukaryotic cells enter into mutually beneficial relationships with the host cells that have incorporated them; they become a part of the nucleated cell and yet remain distinct within it. A eukaryotic cell is therefore not an indivisible whole, but rather an entire community of distinct agents. The same logic applies to the bodies of animals and plants, to ecosystems, and ultimately to Gaia itself. Each of these entities possesses a limited capacity to self-regulate, but this capacity does not inhere in any of their constitutive components, but rather must be understood as an emergent property of their interactions: “The sum of planetary life, Gaia, displays a physiology that we recognize as environmental regulation. . . . [An] enormous collection of interacting ecosystems, the Earth as Gaian regulatory physiology transcends all individual organisms” (Margulis 119-20). Crucially, though, this does not mean that Gaia is a soup of poorly circumscribed, promiscuously hybridizing agents. Rheinberger remarks drily that “Margulis would

not agree with [Latour's] characterization of the surface of the earth and its atmosphere as simply a 'fine muddle'" (34). Just as for the systems that form her composite body, the ability of Gaia to stabilize and self-organize rests precisely on her capacity to distinguish between an inside and an outside, to mark and maintain a difference between the system and its environment.

As her understanding of Gaia matured, Margulis increasingly conceived of this process of self-production and self-maintenance as an instance of *autopoiesis*—a concept that, while primarily associated with the Chilean biologists Francisco Varela and Humberto Maturana, belongs to a much broader strand of cybernetic thought that is in many ways distinct from the one which had guided Lovelock to his initial formulation of the Gaia hypothesis (Clarke, "Margulis"). This approach has been variously referred to as neocybernetics or second-order cybernetics, but the most telling designation is surely that of Heinz von Foerster, one of the movement's original protagonists, who playfully referred to it as "the cybernetics of cybernetics," also glossed as "the control of control" (von Foerster). As these terms already suggest, neocybernetics starts from the self-application of cybernetic theory: whoever seeks to describe or control a cybernetic system must herself be such a system. Autopoietic systems, as neocybernetic theory conceives them, persist because they selectively close themselves off from their environment (think of how membranes shield cells from their surroundings, how the skin both connects organisms to and separates them from their environment, or how the Earth's atmosphere filters cosmic radiation such that the planet's surface remains favorable to biological life). They are what they are only because they are able to distinguish between self and other: autopoietic systems engender themselves by engendering their environment. Autopoiesis is thus also the most basic form of cognition, and cognition is a function of the system's operational closure. Such systems possess a dynamic of their own that is not amenable to direct control from outside. And unlike the homeostatic machines of classical cybernetics, autopoietic systems are historical—they do not converge toward a single, predetermined stable state, but are always the contingent product of their efforts to reproduce the difference by which they constitute themselves as systems, for as long as they can.

As we have seen, Serres himself suggests that society must be conceived as a system in its own right, and when he describes the problem that world society faces at this juncture of its history as one of "master[ing] our own mastery" (37), it is tempting to hear in this an echo of von Foerster's "control of control." But at least in *The Natural Contract*, Serres's cybernetics remains by and large of the first-order kind. This, I suspect, is also the reason why he can range so freely

between normative and descriptive registers, such that the natural contract features on some occasions as an objective condition of human survival, and on others as a kind of moral imperative to care for the world—implying that even though humans may not be able to steer the Earth system, they do have both the ability and the duty to steer their own ship of state. A more rigorous attempt to conceive of society as an autopoietic system, such as one finds in Niklas Luhmann’s theory of social systems (in *Theory of Society*), would leave much less room for the lyricism and visionary pathos that lend Serres’s text so much of its beauty and rhetorical force, and it would throw into question whether we have really left modernity behind. It might, however, also allow for a more clear-eyed assessment of the real efficacy of IPCC reports, Anthropocene exhibitions—or philosophical treatises such as *The Natural Contract*.

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***Manuscript received 6 Apr. 2020,
accepted for publication 30 July 2020*