



# WRITING POSTHUMANISM, POSTHUMAN WRITING



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## 13 Evolutionary Equality: Neocybernetic Posthumanism and Margulis and Sagan's Writing Practice

Bruce Clarke

Beginning with *Microcosmos: Four Billion Years of Evolution from Our Microbial Ancestors* (1986), microbiologist Lynn Margulis and science writer Dorion Sagan have authored a series of expositions on life, sex, evolution, and the biosphere.<sup>1</sup> Briefly stated, these volumes do not purvey the anthropocentric, hence "selfish," gene-centered neo-Darwinist biology one gets from an author such as Richard Dawkins. Rather, they present cell-centered, microcosmic and Gaia-connected autopoietic-systems biology. As I will discuss, Margulis and Sagan's longstanding investment in the concept of autopoiesis for a discourse on evolutionary biology is particularly crucial: it consolidates the identification of their discourse as a dialect of neocybernetic posthumanism. Margulis and Sagan do not introduce either term of this latter phrase into their self-descriptions. Nonetheless, their pervasive displacement of the human from a central role in a biosphere returned to Gaia's true inside players, the microbes, yields a form of posthumanism worthy of serious contemplation. This article starts with definitions of the posthuman and of two varieties of posthumanism, followed by a brief excursus on systems theory and deconstruction in relation to writing. It then pays particular attention to Margulis and Sagan's *Microcosmos* for its development of scriptive and rhetorical strategies, and for its accretion, in the paperback edition, of a self-reflective preface that works out a resolution of their own writing practice in relation to their posthumanist constructions. I conclude with a consideration of Gaia theory as a dialect

of neocybernetic posthumanism, and assess Margulis and Sagan's adherence to the discourse of autopoiesis in this context.

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Posthumanism is to be distinguished from the posthuman. The posthuman is an image, of desire or dread, the image of some entity or state coming after the time or the state of the human. For instance, a fictional character that begins as a human being but ends up as something other than human would then be posthuman, what I term a posthuman metamorph. In this sense the notion of the posthuman is as old as metamorphic mythopoiesis. At the moment, drawing especially on the cybernetic technosciences, the posthuman imaginary is going stronger than ever, vigorously developed in narrative fictions. For instance, at the end of the movie *Avatar*, once the human protagonist Jake Sully passes permanently into an alien, Na'vi body, he too is officially posthuman, a posthuman metamorph. In contrast, posthumanism is not an image but a discourse, a contested set of philosophical statements or doctrines concerning ways of thinking that stand apart from and may conceivably replace or surpass those philosophies gathered under the name of humanism. This distinction clarifies the circumstance that there's nothing necessarily posthumanist about any given image of the posthuman. The propriety of the philosophical designation will depend on what that posthuman image does, on how it is constructed. So, for example, while the story of *Avatar* drives toward a sort of posthuman climax, one could contest whether the film communicates a posthumanist message, and if so, of what sort. Once again, posthumanism is a contested set of doctrines, a heterogeneous discourse.<sup>2</sup>

It is heterogeneous in that different versions of posthumanism may be distinguished, depending, for instance, upon the particular form of the cybernetics with which they are coordinated. By *neocybernetic posthumanism* I mean to mark for that discourse a crucial distinction between first-order and second-order cybernetics. There are first-order modes of posthumanism that are cybernetic per se. Cybernetic posthumanisms partake of the first-order cybernetic synthesis of information theory with the technosciences of communication and control systems. This earlier cybernetics of signal, noise, and feedback control still remains the primary frame around popular images of the posthuman. The obvious example here is, of course, the cyborg. Elaborated from early cybernetic analogies connecting the homeostatic processes of bodily organs and technological devices, linking organic control systems with commu-

nications technologies, the cyborg image transgressed humanist essentialisms. Donna Haraway's ironic treatments of the cyborg's liberatory potential put it to work doing feminist philosophy, debunking gendered dualisms and other myths of pristine origins by challenging the classical ontological boundaries around sexual difference and the absolute separations of the human, the animal, and the machine (149). As a posthuman image the cyborg has been more than suggestive; however, as a posthumanist concept it has been less than rigorous, and its purchase has shown diminishing returns. Like the *Terminator* franchise, it is running out of creative juice. Cybernetic posthumanism continues in earnest in the movement called transhumanism, which has shown itself to be a retro-humanist fantasy preserving Cartesian priorities, instrumentalizing the body by digitalizing the mind.

What, then, is neocybernetic posthumanism? To begin with, it is a way of doing cybernetics otherwise than as prosthetic variations on the mingling of the mechanical and the organic. In the early 1970s the cyberneticist Heinz von Foerster generalized the concept of computation for a turn toward cognitive systems. This demanded a cybernetics of cybernetics, the self-referential turn von Foerster called "second-order cybernetics." Neocybernetics started here, as a discourse pointed toward the "observation of observation," the point being that a cognitive system in the non-trivial sense has to refer its cognitions to itself, first of all, as the self-constructed ground of possibility of its ability to refer them, when appropriate, to its world.<sup>3</sup> The main line of this second-order systems theory began to form through von Foerster's close working relations with the biologists Humberto Maturana and Francisco Varela as they developed the concept of autopoiesis. In an autopoietic system, cognitive self-reference takes the form of operational self-production maintained by an organizational closure, not of the system *tout court*, but of the autopoietic process internal to it. Maturana and Varela's material instance of an autopoietic system is the living cell. In their formulation, living processes—selecting and transforming the elements in its environmental medium so as to produce its own continuing production of selective transformations—are coterminous with a basal sense of cognition, what Margulis and Sagan will come to term *sentience*. Sociological systems theorist Niklas Luhmann lifted autopoiesis out of its biological instance for a general theory of self-referential, self-producing systems encompassing but also enclosing psychic and social levels of operation, the autopoiesis of consciousness and the autopoiesis of communication.

Neocybernetic posthumanism, then, is the view of posthumanism one gets when framing it through this neocybernetic line of second-order systems theory.<sup>4</sup> In this view, the unity of the humanist subject is operationally disarticulated and redistributed within a worldly nexus with a complex inter-embedding of semi-autonomous systems and their environments. Notions of intersubjectivity are dissolved because psychic and social systems do not merge, even as they co-evolve by taking each other as their immediate environments. The self-construction of psychic systems is possible only in ongoing corporeal coupling with living systems, while the self-construction of social systems is possible only in ongoing mediatic relation to psychic systems. One has a situation of complex co-dependencies or co-observances among co-evolutionary partners. The different kinds of autopoietic systems possess operational concurrence—in that living, psychic, and social systems all exhibit the autopoietic, self-referential and self-producing form—but without overriding operational unity, in that each kind of autopoietic system produces only its particular mode of cognition—life, consciousness, or communication, as the case may be. Life is cognition but not yet consciousness, consciousness is not yet communication, and vice versa. Moreover, at right angles to its environmental openness as a cognitive system, any autopoietic system maintains the operational closure of its own processes within its particular medium. Operational closure in the midst of environmental interaction—this is the minimal condition of the viability of organic bodies, as well as of the psychic and social systems that emerge from them. This is also the form of their capacity both to observe and to couple with other systems.

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In the tradition of Western metaphysics, the privileging of speech over writing has also privileged—over and above mind over body—mind over society, consciousness over communication. In second-order systems theory, or neocybernetics, Luhmann's contention that "humans can't communicate" is a deliberate provocation, disarming this high-humanist presumption of subjective prerogative with the posthumanist dictum that "only communication can communicate." In other words, once social systems are observed as constituted by the recursive reproduction of communicative events, human beings properly reside in their environments.<sup>5</sup> It is social systems that succeed, when they do so, of producing and reproducing communications. To avail themselves of that operation, to "participate in communication," individuals must couple

themselves by means of material media to a human, supra-individual systems.<sup>6</sup> With regard to the relation between systems theory and deconstruction—two prime dialects of posthumanist discourse—Cary Wolfe notes that Luhmann

makes essentially the same point about the difference between "consciousness" and "communication" that we have quite readily accepted for decades now as gospel from Derrida—namely, his deconstruction of the "auto-affection" of the voice-as-presence and of the valorizing of speech (as an index of the self-presence of consciousness to itself) over writing (a recursive domain of iterative communication that is, properly understood, fundamentally ahuman or even antihuman).

Wolfe is an important thinker at this crucial intersection, particularly due to his illumination of the resonance between the systems theories of Luhmann and the deconstructive axioms of Derrida. As we see in the passage just given from "Meaning as Event-Machine," Wolfe's seminal insight is that Derrida's disarticulation of speech and writing closely maps onto Luhmann's disarticulation of consciousness and communication.

Moreover, in a manner that deepens Derrida's scheme, Luhmann's operational template disarticulating consciousness and communication also lifts the interrelation of language and meaning out of the specifically human linguistic moment. Derrida's deconstruction of the speech/writing opposition is a conceptual insight carried out at the level of the linguistic signifier; Luhmann's disarticulation of consciousness and communication is a functional distinction carried out at the level of systemic operations. Speech per se is not a modality of consciousness, but it produces clamorous psychic effects due to the self-affection of a speaking subject. And unlike writing, which can wait for its moment to have social effects, spoken traces must be registered by a co-present consciousness in all of its extra-conscious materiality and systemic capacity. After all, the point of producing speech is usually its social, not just its conscious, effect. In other words, both speech and writing are properly taken as different modes of *communication*. From the social point of view (typically elided by metaphysical and linguistic discourse), speech is just as external to the "self" as writing is. But due to the auto-affection of the speaking subject, it doesn't *feel* at first that ahuman externalities are always already in play the moment one speaks.

Wolfe underlines how for Derridean posthumanism the written trace—the logic of the *grammè*—marks the contingency of the self-production of events of consciousness upon “exteriority in general.” But Wolfe also systems-theorizes Derrida by unfolding his notion of general exteriority—“The trace is the intimate relation of the living present to its outside, the opening to exteriority in general” (from Derrida’s *Speech and Phenomena*)—with a specification of some particular modes of exteriority. That is, Wolfe observes the kinds of environments to be coordinated with the systems for which writing is one kind of operation: “Herein lies the radically posthumanist dimension of writing-as-difference: the subject . . . only comes to be by conforming to a strictly diacritical system of differences. . . . Moreover, those effects and relations are at once material, bodily, external, institutional, technological, and historical” (227).

In the introduction to *What is Posthumanism?*, Wolfe notes that “Luhmann’s handling of systems theory accomplishes just the sort of ‘conservation’ of the logic of the *grammè* that Derrida calls for, a conservation that is crucial to any posthumanism whatsoever,” by referring Derrida’s evocation in *Of Grammatology* of the cybernetic program as a machine-writing to Luhmann’s neocybernetic operationalization of concurrent and coevolutionary systems. In Luhmann’s coordinated disarticulations of self-referential autopoiesis in biological, psychic, and social systems, their simultaneous semi-autonomies explode and replace the notional unity of the human subject. Derrida’s writing-in-general then provides an ahuman infrastructure germane to any and all of them: “once the notion of the program is invoked, one no longer has ‘recourse to the concepts that habitually serve to distinguish man from other living beings (instinct and intelligence, absence or presence of speech, of society, of economy, etc. etc.)’” (8).

In sum, systemic posthumanism in Derrida and Luhmann immerses the human once more into the multiplicity of environments constituted by the multiplicity of biotic and metabiotic systems for which the human has always been implicated. Writing itself is immersed into a sea of operational sentience, a welter of autopoietic cognitions, whether these are consciously immediate or socially delayed. Communication itself may be rethought as an emergent evolutionary process shared out wherever social autopoiesis has chanced to happen. It is this neocybernetic form of posthumanist observation that will characterize the micro- and macro-cosmic posthumanism of Margulis and Sagan.

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Let us back up and review some of Margulis and Sagan’s biographical and collegial contexts. The literary chemistry of this family team may be unprecedented. Over and above its transmission of a singular synthesis of scientific ideas, the literary quality of its science writings is certainly unrivalled. A social and scholarly prodigy born in 1938, Margulis matriculated at the University of Chicago at fifteen. She dated graduate student Carl Sagan at sixteen and married him at nineteen, the year she received Chicago’s multidisciplinary undergraduate degree. She then became a scientific prodigy who persevered against academic and disciplinary headwinds through two marriages and four children to establish herself professionally by the turn of the 1970s. Born in 1959 of uncommonly literate world-class scientists, Dorion Sagan took a literature and philosophy major and established himself as a polymath wordsmith with a well-tempered and timely exposure to poststructuralism as well as a cosmopolitan knowledge of scientific matters. Both Margulis and Sagan now have extensive separate publications, but their twenty-five-year-long span of collaborative writing stands out for its unique blend of hard scientific erudition, speculative and theoretical audacity, pugnacious candor, and literary style.

How, then, does one write science for non-scientists in a way that challenges and ultimately subverts the verities of scientific humanism? How does one present what amounts to a posthumanist scientific discourse to a general audience largely unconscious of its inherited humanist assumptions? Margulis and Sagan carry this off by working from a suitably paradigm-shifting scientific vision, conveyed through an astute selection of expository and rhetorical techniques. I begin an analysis of their writing practice with some close readings of a pivotal source and literary model. In *Microcosmos* Margulis and Sagan borrow several techniques at work in the signature text of a biological popularizer who preceded them, *The Lives of a Cell* by Lewis Thomas. In this collection of short articles first published in the *New England Journal of Medicine* in the early 1970s, Thomas was popularizing the new bioscience of, among others, Lynn Margulis, as her seminal work on “serial endosymbiosis theory” (SET) was then coming forward.<sup>7</sup> Her confirmation and reconfiguration of earlier suggestions about the origins of cellular organelles and cytoplasmic (non-nuclear) genes has now rewritten the textbooks on the evolution of the eukaryotic or nucleated cell. In SET, the cilia of eukaryotes originate as spirochetes, mitochondria as purple bacteria, and chloroplasts as cyanobacteria, before being absorbed, one at a time (“se-

rially" over many hundreds of millions of years), into organellar status within evolving iterations of the eukaryotic cell.<sup>8</sup> For his part, Lewis's writings modeled the vivacity possible in popular science writing, and concocted some proto-posthumanist templates for the contemplation of this evolutionary scenario at the microbial level.

For instance, Thomas figures this new understanding of the hybrid nature of the nucleated cell as the dispossession of a prior presumption of human—more precisely, modern Western bourgeois—proprieties: "I was raised in the belief that [organelles] were obscure little engines inside my cells, owned and operated by me or my cellular delegates, private, submicroscopic bits of my intelligent flesh. Now, it appears, some of them, and the most important ones at that, are total strangers. . . . I only hope I can retain title to my nuclei" (82–83). One could call this the "trading places" scenario—here, the owner becomes the owned, the operator the operated. A page later Thomas offers another variation of this tactic of narrative peripeteia or reversal of perspective: "The usual way of looking at [organelles] is as enslaved creatures. . . . This master-slave arrangement is the common view of full-grown biologists, eukaryotes all. But there is the other side. From their own viewpoint . . . I could be taken for a very large, motile colony of respiring bacteria" (84). Margulis and Sagan will develop this shot-countershot technique in their own writings, for the good reason that it yields another way to envision the relinquishing of nominal humanist unity for the posthumanist appreciation of coordinated systemic multiplicities. Not only are we humans (and most other postbacterial organisms) multicellular in composition, but each eukaryotic cell therein is itself multi-genomic, a consortium of differential genomes retaining operational semi-autonomy, as Thomas notes in a particular, "respiring" instance—the oxygen-processing mitochondria that endow the eukaryotic cells of prototists (e.g., algae), animals, fungi, and plants with their aerobic capacities: "The mitochondria do not arise *de novo* in [eukaryotic] cells; they are always there, replicating on their own, independently of the replication of the cell" (82–83).

Thomas wrote the foreword for *Microcosmos*. In it he revisited these place-trading scenarios. Not so long ago, he writes there, the "general sense was that Nature is a piece of property, an inheritance, owned and operated by mankind. . . . But there is another way to look at us, and this book is the guide for that look" (10). From this unfolds another technique, also worthy of retrospective labeling as a posthumanist trope—pronominal manipulation, a destabilizing of the humanist "we":

"We used to believe that *we* arrived *de novo*, set in place by the Management" (11); but then came Darwin, and then came the newer, microbial revelations of Margulis and company: "In evolutionary terms, *we* have only just arrived. . . . The first of *us*, the very first of our line, appeared sometime around 3.5 billion years ago, a single bacterial cell. . . . *We* go back to *it*, of all things. . . . Our microbial forebears . . . are still with *us*, part of *us*. Or, put it another way, *we* are part of *them*" (11; emphasis added). This way of insinuating hereditary continuities through subverting the stability of separate biological identities shows up on occasion in Margulis and Sagan, for instance, in their follow-up volume to *Microcosmos*, *What is Life?*: "As sheer persistence of biochemistry, '*we*' have never died during the passage of 3,000 million years. . . . *We* have, of course, had to 'up the stakes' at various junctures to stay alive" (81; emphasis added). Here, the insertion and then removal of scare quotes around a first-person plural pronoun whose antecedent is all the life forms that have ever lived, as an evolutionary whole, these pronouns communicate *our*—Life's—communality, the communal status of all past and present living beings.

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Margulis and Sagan's *Microcosmos* carries out a critique of anthropocentric arrogance. It pursues a posthumanistic writing practice, for one instance, in its broad relinquishing of the pretense of scientific certainty as an index of humanity's overcoming of its humble natural origins. Riffing on this refreshing sensibility, Thomas concluded his foreword with the etymology that links *human* and *humble* by way of the Earth deposited in their roots: "It is there like a linguistic fossil, buried in the ancient root from which we take our species' name. The word for earth . . . was *dhghem*. From this word . . . came our word *humus*, the handiwork of soil bacteria. Also, to teach us the lesson, *humble*, *human*, and *humane*" (12).<sup>9</sup> Note the relative humility with which Margulis and Sagan, at the outset of their narrative, underscore the provisional status of scientific knowledge, especially of matters relating to the eons before life on Earth began. Concerning the origin of the Earth, the representation they give is, in all modesty, "the best picture we have": As with "any other look into what Shakespeare called 'the dim backward and abysm of time,' we must not mistake our best guesses or relatively straight-line extrapolations of present conditions into the past for the literal truth. . . . Nevertheless, such extrapolations yield the best picture we have of the cosmos which preceded the evolution of life in the microcosm" (39–40).<sup>10</sup> Similarly,



when they broach the Gaia hypothesis—of which Margulis is the second author, after James Lovelock—they render it in its proper uncertainty.<sup>11</sup> Even before the evolution of the eukaryotic cell, “Microbes by themselves *are thought* to have maintained the mean temperature of the early Earth so that it was hospitable for life. . . . Barring divine intervention and luck, only life itself *seems* powerful enough to have promoted the conditions favoring its own prolonged survival in the face of environmental adversity” (66–67; my italics).

The paperback edition of *Microcosmos* adds to the earlier volume a remarkable preface. It foregrounds, directly after the republication of Thomas’s foreword, a self-critique of the rhetorical strategy they likely borrowed from Thomas, role reversal between humanity and the microbes. While that aspect of the main text is left intact—only the notes are revised and updated, the new preface nevertheless indicates as a philosophical desideratum a movement beyond the hierarchical binaries in which either human or nonhuman nature is placed on top of the other. However, audaciously, this self-critique is itself framed by a second self-critique, with a different “we,” directed outward toward their fellow humans, launching a straightforward mockery of human pretensions to planetary dominion. Rhetorical indirection now gives way to a blunt rebuttal directly to arguments, scientific and otherwise, that inflate humanity’s planetary ego. The bracing opening paragraph of the preface they add to *Microcosmos* reads:

What is the relationship between humans and Nature? The Linnaean, or scientific, name of our own species in *Homo sapiens sapiens*—“Man, the wise, the wise.” But, as a humble proposal or wisecrack, we suggest that humanity be rechristened *Homo insapiens*—“Man, the unwise, the tasteless.” We love to think we are Nature’s rulers . . . but we are less regal than we imagine. *Microcosmos: Four Billion years of Evolution from Our Microbial Ancestors* (first published in 1986) strips away the gilded clothing that serves as humanity’s self-image to reveal that our self-aggrandizing view of ourselves is no more than that of a planetary fool. (13)

This is posthumanist indiscretion of the highest order, a most superb humility. What immediately follows is equally remarkable and, I would wager, unprecedented in a book of popular scientific exposition. Surely coming from Dorion Sagan’s side of the collaboration, it is a suggestion

regarding the indiscretion of *writing* altogether, with reference to Plato and Socrates, and, although unstated, to the dialogue *Phaedrus*. Margulis and Sagan invoke Socrates for another reason. He was no planetary fool, but had the wisdom to confess his own ignorance: “Through Plato, Socrates speaks of the folly of inscribing one’s opinions: although your views may change, your words as committed to paper remain. Socrates at least did not write, and what he knew, first and foremost, was that he did not know. We, however, did write” (14). In the *Phaedrus*, you will recall, Socrates relates the myth of Thoth and the King. The inventor of writing, Thoth offers it as a gift to the King, praising it as a *pharmakon*, a potion with a remedy for forgetfulness. Regarding this drug, the King replies, just say no; while it supplements, it also anesthetizes the memory, and it substitutes for the changeable life of the spoken word a static tissue of dead traces:

Reversing the usual inflated view of humanity, we wrote of *Homo sapiens* as a kind of latter-day permutation in the ancient and ongoing evolution of the smallest, most ancient, and most chemically versatile inhabitants of the Earth, namely bacteria. . . . Unlike spoken words floating off noncommittally into the fickle winds of opinion, our words as hard symbols on paper sat, as here they sit—obstinately confronting us with dogma and didacticism instead of what otherwise might have been merely a provisional opinion. Happily, though, the occasion of the paperback reprinting of *Microcosmos* offers us an opportunity, if not to rewrite and revise, at least to reflect on the book and its main concerns. (14–15)

Writing is addictive: the only cure for it is more writing. Systems-theoretically, this is just to say that social autopoiesis demands that one communication lead to another, ad infinitum. The parallel to biological autopoiesis is clear: life cannot correct what it has been, it must just keep going and, if it can, as a result, over time, it becomes, not something better, but something else. In Margulis and Sagan’s writing practice, what we witness in the preface to *Microcosmos* is a sophisticated self-referential moment, a brief discourse upon their own discourse. It is not a moment of self-correction, since the prior text still stands. It is rather a moment of self-adjustment, announcing a change of strategy. Having taken some initial cues from Lewis Thomas, they applied the trope of reversal at book length to the human/microbe opposition. The process

was certainly productive: the book is vibrant, bristling with information and attitude, with certainly no more, likely rather less "dogma and didacticism" than one finds in any comparable popular evolutionary text. However, this rhetorical strategy did tend to squeeze out consideration of the biological middle ground, most every living thing lying between microbes and humanoids. The chapter "Late Bloomers: Animals and Plants" is only one out of thirteen. *What is Life?* adjusts this balance to brilliant effect. The imbalance of *Microcosmos*, relative to the breadth of life altogether, would be, I think, the sole evidence justifying their self-indictment of "overcompensation": "*Microcosmos* approaches . . . large questions from the particular perspective of a planet whose evolution has been largely a bacterial phenomenon. We believe this formerly slighted perspective is a highly useful, even essential compensation required to balance the traditional anthropocentric view which flatters humanity in an unthinking, inappropriate way. Ultimately we may have overcompensated" (18). Perhaps, but in any event, "dogma and didacticism" are what one does *not* want to purvey if the point of the exposition is to reformat a general reader's most basic ideas about humanity's place in the larger scheme of life.

Their self-critique immediately continues with an appearance from Jacques Derrida. One wonders whether "Plato's Pharmacy" is lurking behind the appearance of Socrates and the ironic demotion of writing a few pages earlier. Be that as it may, one just does not expect to encounter Derrida in a trade paperback edition of popular science writing: "In the philosophical practice known as deconstruction, powerful hierarchical oppositions are dismantled in a dual process Jacques Derrida caricatures or characterizes as 'reversal and displacement.' This process is at work in *Microcosmos*: humanity is deconstructed as the traditional hierarchy—recently evolved humans on top, evolutionarily older 'lower' organisms below—is reversed" (18). That a discussion of Derrida and deconstruction occurs here at all brings us back to the considerations of posthumanism with which we began. Is posthumanism to be nothing more than the reversal of a hierarchical opposition starting with the human installed on top, whether it be human/microbe, human/animal, or human/machine? Images of the posthuman often take this more simplistic form. Just as often they evacuate their posthumanist credentials when such narratives climax with restorative reversals of the initial reversal, as the evil machines, or the nefarious aliens, or the mindless killer viruses are vanquished in some spectacular fashion. Nor does mere reversal, the de-

feat or utter humbling of the human, amount to a robust posthumanism. This is the crux of the deconstructive component of Margulis and Sagan's self-critique: "from the view of deconstructive practice, *Microcosmos*, which reverses the hierarchical opposition, does not take the next step of displacement: man is taken off the top of nature only to be put on the bottom. What ultimately must be called into question is not the position assumed by humans in the opposition Man/Nature but the oppositional distortions imposed by hierarchy itself" (18).

Here, in the movement beyond binary hierarchy, is the crucial adjustment that fully releases Margulis and Sagan's discourse into the second-order posthumanism of *What is Life?* and their other subsequent writings. Philosophically, humanism is contaminated with the hierarchical assumptions that tether it back to the theological mindsets of which it is the oppositional reversal. One sees this all too often in (pseudo-)secular science writings, especially of an evolutionary cast, when the qualifiers "higher" and "lower" are applied to life forms. For instance, in her early days, Margulis herself purveyed a humanist rhetoric, presumably absorbed from her standard biological training. Note the hierarchical formulations in this passage from her 1971 *Scientific American* article listed in the references of *The Lives of a Cell*, "Symbiosis and Evolution," compounded by progressivist notions of evolutionary "advance" and "perfection":

Mitotic cell division was the crucial genetic step toward further evolutionary *advance*. One would not expect it to have developed in a straight-line manner, starting with no mitosis and concluding with *perfect* mitosis. There must have been numerous dead ends, variations and byways. Evidence of just such uncertain gradualism is found today among the *lower* eukaryotes, for example the slime molds, the yellow-green and golden-yellow algae, the euglenids, the slime-net amoebas and others. Many of their mitotic arrangements are unconventional. The *perfection* of mitosis must have occupied as much as a billion years of Precambrian time. (10; emphasis added)

By the time she co-writes *Microcosmos* fifteen years later, Lynn Margulis has sloughed off this sort of conventional science prose and surpassed the evolutionary attitudes it implies. But it remained for the composition of their supplementary preface, and Dorion Sagan's transfusion of philosophical self-awareness into it, to bring out an explicit articulation

of the new, virtually posthumanist orientation of their current evolutionary discourse. Let's return to the preface. Margulis and Sagan continue: "Nearly all our predecessors assumed that humans have some immense importance, either material or transcendental. We picture humanity as one among other microbial phenomena, employing *Homo insapiens* as a nickname to remind ourselves to stave off the recurring fantasy that people master (or can master) Gaia. The microbial view is ultimately provisional; there is no absolute dichotomy between humans and bacteria" (18–19).

I want to claim this superb proposition for neocybernetic posthumanism. Just as "there is no absolute dichotomy between humans and bacteria," there is no absolute dichotomy, period. All dichotomies are provisional. This can be restated in the language of systems theory by saying that all dichotomies are self-referential cognitive constructions produced on the inside of observing systems. Thought is not possible without them, without making distinctions from moment to moment, but dichotomies are all relative; they relate to the contingencies of their systemic production. They refer in the first instance to the dichotomizing system, and only then, it may be, to the dichotomized environment. For instance, Margulis and Sagan have just distinguished between a hierarchical and a post-hierarchical philosophy of living things. This meta-dichotomy has the great virtue of rendering fine-grained information about the doctrinal self-awareness as well as the specific doctrines of the writers of this popular science text. On that basis we may grant them epistemological authority on a matter that must appear to many readers as utterly counter-intuitive—the notion that the long unfolding of biological evolution has *not* entailed any "advancement" or "perfection" of species. I know the resistance to this rethinking for a fact from my experience teaching Margulis and Sagan texts in my literature and science classes. Inculcated as they are in conventional humanist attitudes, if not also in theological notions of a creationist and/or moral-perfectionist stripe, many of my students are at first taken aback particularly by those passages in which Margulis and Sagan put into discursive practice what they have just preached in the preface to *Microcosmos* about the surpassing of absolute hierarchical dichotomies. Passages like these:

From the paramecium to the human race, all life forms are meticulously organized, sophisticated aggregates of evolving microbial life. Far from leaving microorganisms behind on an evolutionary "ladder," we are both surrounded by them and

composed of them. Having survived in an unbroken line from the beginnings of life, all organisms today are equally evolved. (*Microcosmos* 28)

All extant species are equally evolved. All living beings, from bacterial speck to congressional committee member, evolved from the ancient common ancestor which evolved autopoiesis and thus became the first living cell. (*What is Life?* 48)

All beings alive today are equally evolved. All have survived over three thousand million years of evolution from common bacterial ancestors. There are no "higher" beings, no "lower animals," no angels, and no gods. The devil, like Santa Claus, is a useful myth (3).<sup>12</sup>

Each of these radical affirmations of evolutionary equality stresses contemporaneity, the temporal simultaneity of the material biosphere. Cell by cell, from moment to moment, each autopoietic unit of life does or does not maintain itself as a living system. It is not a mere tautology to insist that, as a composite result of each separate but interdependent evolutionary history having brought it to this moment, all life is equally living at that moment. Currently coexisting life is an ongoing self-maintaining achievement in itself. This Gaian vista evacuates any vestiges of a teleological approach to evolutionary processes. By whatever means necessary, "all beings alive today" have managed to continue their lines to this moment: the continued self-maintenance of one's species is the measure of an equality of evolutionary outcome. This is the gist of the statement cited from Margulis and Sagan earlier, that "we"—the collective phenomenon of life in the profusion of its evolutionary history—have "had to 'up the stakes' at various junctures to stay alive. This continuous 'upping of the stakes' . . . is on the species level described as evolution. Beings . . . often . . . have to evolve, to change into new forms, simply to self-maintain. . . . Evolution, no less than the nucleic acid replication of autopoiesis and reproduction, is a 'stumbling forward' to stave off the threat of thermodynamic dissolution" (*What is Life?* 81). In other words, regarding evolution, it is not that the *forms* of life get "higher," it is that the *stakes* that life must wager against entropy do. It is this cosmic dynamic that drives the evolution of Gaia altogether into *more complex* individual forms and more complex co-evolutionary arrangements with their environments.

We note here as well Margulis and Sagan's coupling together the logic of evolution with the logic of autopoiesis. This bio-logic must



give autopoiesis priority: "To be alive, an entity must first be *autopoietic*—that is, it must actively maintain itself against the mischief of the world. . . . This modulating, 'holistic' phenomenon of autopoiesis, of active self-maintenance, is the basis of all known life" (*Microcosmos* 56). Life must first exist and then maintain its existence in order for there to be something to evolve. When Maturana and Varela, the inventors of the concept of autopoiesis, approach the matter of biological evolution, they develop a relatively passive model of "natural drift" in the structural coupling of organisms and environments over geological time.<sup>13</sup> In contrast, with a boost from the work of Erich Jantsch, Margulis and Sagan inscribe autopoietic self-maintenance into the abiotic dynamics of far-from-equilibrium thermodynamics and the metabiotic cycles of geobiological processes.<sup>14</sup> Theirs is a more compelling description of an autopoietic "impatience" impelling Gaia altogether to "stumble forward" through incessant testings of hereditary variations and recursive inventions of favorable niches, maintaining geobiological momentum against physical inertia.<sup>15</sup> Autopoiesis is rounded out here as the necessary conservation of the self-referential form of metabolic self-production achieved through evolutionary time by structural compensations for the continuous recursive tweakings of life forms by environmental contingencies. Margulis and Sagan encapsulate their fusion of autopoiesis and evolution this way: "Changing to stay the same is the essence of autopoiesis. It applies to the biosphere as well as the cell. Applied to species, it leads to evolution" (*What is Life?* 31).<sup>16</sup>

\* \* \*

I will conclude by inscribing Gaia theory explicitly into the discourse of neocybernetic posthumanism. As we have seen, Margulis and Sagan not only extend an autopoietic approach to evolutionary theory, they also initiate an autopoietic approach to Gaia theory: "The biosphere as a whole is autopoietic in the sense that it maintains itself" (*What is Life?* 20). Insofar as the form of autopoiesis may be generalized to psychic and social systems, this connection suggests a second-order posthumanism addressed to the formal and operational (systems-theoretical) rather than genetic and reproductive (neo-Darwinist, sociobiological) interrelations between geobiology on the one hand and minds and societies on the other. Here is a strong recent comment from Myra Hird's *The Origins of Sociable Life* approaching this theoretical terrain from within feminist science studies: "Gaia theory emphasizes lively biotic/abiotic

co-productions that sustain the biosphere. In so doing, it collapses the traditional social scientific distinction between living and nonliving matter. Second, Gaia theory shifts the focus from animals to bacteria. . . . For Gaia theory, studying animals is essentially another way of studying ourselves: humanocentric business-as-usual" (130).

Despite the evident posthumanism of such a statement, however, Hird does not evoke that description for her treatment of relations between the bacterial microcosm and the Gaian macrocosm. So let me briefly summarize the implicit case this article has also been making for Margulis and Sagan's revision of Gaia theory as a form of neocybernetic posthumanism. Gaian science altogether is bound up with Margulis's work, especially as, from the early 1970s onward, she collaborated with Lovelock to infuse her microbiology into his framework of geochemical ideas on planetary self-regulation. As we have also seen, persistently ushering the human off center-stage in the evolutionary drama in order to give the microbes starring roles, Margulis and Sagan's expositions of the microcosmos constitute a posthumanist discourse. They inform us that all bacteria living today, as well as the algae, the fungi, the plants, and the other animals, are equally evolved—as thoroughly honed and culled through eons of natural selection. Gaia theory in its adequate construction confirms this radical evolutionary leveling and couples it to the global environment.

Lovelock has recently redescribed the theory like so: "organisms and their environment form a coupled system . . . *what evolved was this system, the one that we call Gaia*. Organisms and their environment do not evolve separately" (22, emphasis added).<sup>17</sup> Lovelock's reformulation of Gaia's metasystemic coupling in this fashion, whether or not this was his intention, helps to undo the superorganicism that has plagued popular notions of this discourse, as well as a number of Lovelock's own statements. In fact, the Earth is not alive. Gaia is not a living superorganism. These organic metaphors have sidetracked the theory for many observers, and rightly so. It is better systems theory to turn the observation around in order to see that life in any of its forms or in its entirety is also on the same plane as the evolving Earth within which those forms unfold. Ever since the bacteria took over the planet, there has been *a Gaian evolution of the biosphere altogether*. All living and nonliving things within the biosphere—human beings and their vaunted technologies included—are interconnected, and no Earthly system, Gaia included, has any more ultimate control than any other. Moreover, in its neocybernetic

redescription, Gaia need assume neither the form of a living system, nor the agency or *anima* of a conscious system, to comprise an *autopoietic* phenomenon—to be a self-referential cognitive system producing self-maintaining regulatory dynamics.

Neocybernetics is the form of systems theory adequate to the thought of an autopoietic planet in which Gaia emerges not as a living being but as an operationally closed, hence autonomous and cognitive, metabiotic geobiological phenomenon. Margulis and Sagan's adaptations of autopoiesis to Gaia theory bring it to the threshold of such a neocybernetic consideration: "The simplest, smallest known autopoietic entity is a single bacterial cell. The largest is probably Gaia—life and its environment-regulating behavior at the Earth's surface. Cells and Gaia display a general property of autopoietic entities: as their surroundings change unpredictably, they maintain their structural integrity and internal organization, at the expense of solar energy, by remaking and interchanging their parts" (267, 269). In order to develop further, both as a scientific discourse and as a form of posthumanist philosophy, autopoietic Gaia theory could be developed beyond the point to which Lovelock and Margulis have brought it and further reformulated along neocybernetic or second-order systems-theoretical lines.

A common misunderstanding must first be overcome: an autopoietic description of living systems does not undermine the functions of symbiosis and symbiogenesis for Gaian dynamics. In an article drawn from *The Origins of Sociable Life*, as well as in that book, Myra Hird gets tangled in a misapprehension about the "autonomy" produced by autopoietic closure. While she states correctly that "Gaia, for Margulis, is autopoietic insofar as it is a system that produces the components that produce its own organization," her continuation is based on a second-hand grasp of the detail of second-order systems theory drawn from flawed sources: "insofar as autopoiesis stresses the individuated self that creates its own environment, it undermines symbiosis and symbiogenesis, which operate through assemblages proliferated more through contamination and contagion than the interaction of autonomous entities" (61). However, the autopoietic system/environment distinction is not an absolute dichotomy. Autopoiesis produces semi-autonomy in the same sense that a biological membrane is semi-permeable. Autopoietic cognition concerns the capacity of that system, within viable limits, to select what crosses its boundaries. The operational boundedness of autopoietic processes in no way precludes the structural coupling, nor even the op-

erational merger, nor any other environmental interactions of autopoietic systems—as long as autopoiesis is preserved in the host system. To the contrary, as William Irwin Thompson has remarked, striking the right note of cosmic bemusement: "Paradoxically, Varela's thesis that 'Every autonomous system is operationally closed' results, rather whimsically, in a universe of openness. Small disturbances can accumulate, and the cumulative effect is to unfold a world" (119–120).

Precisely as second-order systems theory, autopoietic Gaia theory poses crucial epistemological challenges within and without science proper and offers much-needed reorientations of thinking altogether. The cultural returns one can anticipate from its successful accession to paradigmatic status are profound. Moreover, the lines that connect Gaia theory to neocybernetic discourse can go both ways. It may be that the metabiotic resolution that generalized autopoiesis and so moved it beyond the limitation to biotic specificity can now go back in the biotic direction in order to reconceptualize the forms of life's linkages with its abiotic, non-autopoietic milieu. This implication is also folded up in Margulis and Sagan's insistence on Gaia's autopoietic status. Let me try to unfold it.

Psychic and social systems in the autopoietic description given by Luhmann are metabiotic in that they emerge but also depart from living systems. While they process incommensurably different kinds of elements—events of consciousness on the one hand, events of communication on the other—and are thus operationally autonomous, nevertheless, they couple their autonomous operations together. In other words, the extent of their autonomy is strictly internal to their own operations. Externally, their existence is absolutely contingent upon environments that contain other kinds of systems. Moreover, in humans, both psychic and social systems occupy a shared medium of *meaning* introduced by linguistic functions.<sup>18</sup> Luhmann applies the phrase "meaning systems" to both psychic and social systems with regard to their common material and virtual media. Derrida might add that meaning systems are themselves contingent upon the ahuman exteriority of arche-writing.

Could one adapt to the Gaian instance of this second-order schema of a coupled metabiotic emergence dependent upon an environmental stratum? What that would entail is a confirmation that the biotic realm, as coupled to the abiotic, non-autopoietic world, yields a view of Gaia as a metabiotic autopoietic system that, as Myra Hird nicely puts it, "emphasizes lively biotic/abiotic co-productions that sustain the biosphere."

In which case, the metabiotic emergence of the autopoietic and non-autopoietic (technological) systems specific to minds and societies can then be seen as more recent epiphenomena and recursions of the Archean event some 3.5 billion years ago by which life and its planetary environment gave rise to the metabiotic system called Gaia. In this moment, within the geological environment a quantum mass of abiotic and biogenic elements coupled together with the sum of the bacterial biota to lock in an emergent level of metabiotic self-production, autopoietic Gaia—not as a living system, not as a superorganism, in no way as a spirit of the Earth, but nonetheless as a self-referential system of planetary cognition operating to produce globally regulative processes binding together geological and biological evolution into a whole system. Margulis and Sagan expressed this feedback scheme of biotic/abiotic reciprocation in a Gaian chiasmus given at the end of *Microcosmos*: “On Earth the environment has been made and monitored by life as much as life has been made and influenced by the environment” (265).

Now, is there a medium that binds together the non-autopoietic processes of the physical world—with its atomic valences, chemical bonds, radiant and electromagnetic fields, and dynamical and thermodynamical systems—and of the geological world—with its hydrological processes and oceanic, atmospheric, and meteorological systems—with the autopoietic processes that emerged when life began within the non-autopoietic cosmos? If so, this would be the counterpart to the medium of meaning that provides a formal milieu allowing psychic and social systems to coordinate their respective operations. I think that there is a straightforward answer to this. It names a substance that is, akin to the curiously virtual thing we call meaning, infinitely transformative. You will have anticipated the answer—it is *matter*. The metabiotic autopoiesis of Gaia couples together the material-energetic processes of abiotic systems and the autonomous operations of biotic systems within the physicochemical medium of matter. Just as meaning in incessant motion might be called the spirit of autopoiesis at the human level, matter bound up in the coevolutionary forms of Earthly and living transformations is the spirit of Gaia, when its theory is rendered as a dialect of neocybernetic posthumanism.

## NOTES

1. A selection of key texts co-authored by Lynn Margulis and Dorion Sagan: *Microcosmos: Four Billion Years of Microbial Evolution* (New York: Summit Books, 1986; Berkeley: University of California Press, 1997); *Origins of Sex: Three Billion Years of Genetic Recombination* (New Haven: Yale UP, 1986); *What Is Life?* (1996; Berkeley: University of California Press, 2000); *Acquiring Genomes: A Theory of the Origins of Species* (New York: Basic Books, 2002); *Dazzle Gradually: Reflections on the Nature of Nature* (White River Junction, VT: Chelsea Green, 2007).
2. See my *Posthuman Metamorphosis: Narrative and Systems* (New York: Fordham UP, 2008); and “Embodied Mediation: Avatar and its Systems,” in *ZMK—Zeitschrift für Medien- und Kulturforschung* (2012).
3. For details, see Bruce Clarke and Mark B. N. Hansen, eds., *Emergence and Embodiment: New Essays in Second-Order Systems Theory* (Durham: Duke UP, 2009).
4. See my “The Neocybernetic Posthuman,” *Posthuman Metamorphosis*, pp. 193–96; and Bruce Clarke and Mark B. N. Hansen, “Neocybernetic Emergence: Retuning the Posthuman,” *Cybernetics and Human Knowing* 16:1–2 (2009): 83–99.
5. An advanced introduction to the cultural implications of Luhmann’s systems theory is Hans-Georg Moeller, *The Radical Luhmann* (New York: Columbia UP, 2012).
6. See Niklas Luhmann, “How Can the Mind Participate in Communication?” in *Theories of Distinction: Redescribing the Descriptions of Modernity*, ed. William Rasch (Stanford: Stanford UP, 2002), pp. 169–84.
7. Thomas’s references in *The Lives of a Cell* list two texts by Margulis, *The Origin of Eukaryotic Cells* (New Haven: Yale UP, 1970), and “Symbiosis and Evolution,” *Scientific American* 225:2 (1971): 48–57.
8. Margulis continues to explore vectors of symbiogenesis—the evolutionary merger of separately evolved genomes into viable cellular consortia lifting their instructions for various metabolic capacities into higher-order syntheses. See in particular Margulis and Sagan, *Acquiring Genomes*; and Lynn Margulis, Celeste A. Asikainen, and Wolfgang E. Krumbein, eds., *Chimeras and Consciousness: Evolution of the Sensory Self* (Cambridge: MIT Press, 2011).
9. Late in life Lewis published *Et Cetera, Et Cetera: Notes of a Word-Watcher* (New York: Little, Brown, 1990). Despite the charm of his philological investigations, as an old-school archeologist of linguistic fossils trying on some new-fangled sociobiology, on the topic of language Lewis reverts to a classical humanist outlook. While registering unease at the thought that this is the “single” differentiating feature left in the arsenal of humanist separatism, led astray by Noam Chomsky’s biologized linguistics, Lewis writes in *The Lives of a Cell*: “It begins to look, more and more disturbingly, as if the gift of language

is the single human trait that marks us all genetically, setting us apart from all the rest of life" (105). This notion runs counter to the proto-posthumanism otherwise abroad in his properly biological musings, where the key concepts of "society" and "communication" allow Thomas to connect human matters to other living things and their other ways of life. Cary Wolfe provides a formidable philosophical and systems-theoretical critique of the "language makes humans unique" myth in "In the Shadow of Wittgenstein's Lion: Language, Ethics, and the Question of the Animal," *Animal Rites: American Culture, the Discourse of Species, and Posthumanist Theory* (Chicago: University of Chicago Press, 2003), pp. 44–94.

10. This and all subsequent quotations from *Microcosmos* are taken from the revised edition: Lynn Margulis and Dorion Sagan, *Microcosmos: Four Billion Years of Microbial Evolution* (Berkeley: University of California Press, 1997).

11. See for instance Lynn Margulis and James E. Lovelock, "The Atmosphere as Circulatory System of the Biosphere—The Gaia Hypothesis," *CoEvolution Quarterly* 6 (Summer 1975): 31–40; republished in Margulis and Sagan, *Dazzle Gradually*, pp. 157–71.

12. This quote indicates how Margulis, when doing general or "philosophical" writing on her own, as a memoirist without Dorion Sagan as co-author, is rather more blunt and digressive.

13. See "The Natural Drift of Living Beings," in Humberto Maturana and Francisco Varela.

14. See Jantsch, especially the section "Gaia," pp. 115–20.

15. Margulis and Sagan write autopoiesis into their origin-of-life scenario: "Autopoiesis is what happens when a self-bounded chemical system . . . reaches a crucial point and never stops metabolizing. . . . Autopoiesis [is] the chemical basis for the impatience of living beings" (*What Is Life?* 77–78).

16. A good overview of autopoiesis in light of contemporary bioscience is Pier Luigi Luisi, "Autopoiesis: The Logic of Cellular Life," in *The Emergence of Life: From Chemical Origins to Synthetic Biology* (Cambridge: Cambridge UP, 2006), pp. 155–81.

17. See also my "Neocybernetics of Gaia: The Emergence of Second-Order Gaia Theory," in *Gaia in Turmoil*, eds. Crist and Rinker, pp. 293–314.

18. See the chapter "Meaning" in *Luhmann, Social Systems*, trans. John Bednarz, Jr. with Dirk Baecker (Stanford: Stanford UP, 1995), pp. 59–102.

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