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Science, Theory, and Systems
A Response to Glen A. Love and Jonathan Levin

In his response to Glen A. Love's "Science, Anti-Science, and Ecocriticism," Jonathan Levin affirms the "broad contours" of Love's argument: "that humanists would do well to school themselves in the fundamentals of modern science, that the evolutionary paradigm is here to stay, that the prospects for a new alignment of science, especially the life sciences, and the humanities are at least moderately encouraging."[1] Later I will return to some of Levin's further commentary. But at the outset I would like to observe that in Levin's understated version, such propositions could be the basis for some working consensus among ecocritics and my colleagues in the specialization of literature and science.[2] Because both groups are committed to overcoming "the current humanist disdain for science" (Howarth 514), it would be propitious if we could forge some mutual understandings within our own, broadly literary, field. I am moved to reply to Love's article and to Levin's reply, then, because the former, on the basis of some questionable arguments, works against the recognition of such ties, and the latter leaves room for further sharpening of the issues.

Ecocriticism focuses on literary approaches to nature, ecology, and the environment, while literature and science encompasses writings that engage the sciences in general as well as the technologies with which they are bound up. Literature and science ranges widely from media technology to sci-fi; ecocriticism goes deeply into "place." Unlike literature and science, there are phases of ecocriticism when scientific matters are either not at issue or at most peripheral to more immediate literary and natural references. Nevertheless, the natural

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sciences so suffuse the primary objects of ecocritical concern as to be crucial in any capacious view of the field. This situation determines a large area of overlap between ecocriticism and literature and science, and one's adherence to one or the other professional venue seems a matter more of literary taste and personal conviction than of academic specialization.

The intellectual issue that seems most to cut these two camps apart is the matter of "theory." Literature and science discourse swept in at the peak of the theoretical insurgence of the last thirty years, while ecocriticism has emerged in part as a critique of that theoretical tide. I will approach the value of theory in general by returning to Levin's characterization of the first of Love's "contours": "humanists would do well to school themselves in the fundamentals of modern science." Literature and science practitioners also believe in the wisdom of knowing the "fundamentals" of the sciences well enough to speak about them intelligently as well as critically. But it doesn't take much schooling in the history of science to learn that these very fundamentals—for example, the force of gravity, natural selection, entropy, cellular organelles, the primary particles—are under the constant renegotiation that results from the sciences' critical reobservations of their own theoretical premises. Put another way, the fundamentals of science are provisional approximations, asymptotes of reality.[3] They are, dare I say—*constructions*, works perpetually in progress. Those "realists" who invest in the ontic perpetuity of scientific commodities eventually get left in the lurch. Any takers nowadays for phlogiston? caloric? the luminiferous ether? heat death? degeneration? ontogenetically-recapitulated phylogeny? And yet each of these theoretical entities in its day enjoyed the faith and credit of some or all of the scientific establishment. The virtue of theory, scientific or otherwise, is that it is theoretical. Theory is an inherently anti-dogmatic formation, pointed toward self-supersession.

In "Science, Anti-Science, and Ecocriticism," Love extols scientific method as the means by which scientific theories are tested and then validated or discarded, but he also uses it as a club to bash "Marxist, feminist, or even radical environmentalist theoreticians" (66) for what he considers "attractive theories of unreality" (71). He implies that non-scientific theories—whether literary, social, political, or what have you—veer toward "unreality" because they lack the application of scientific method to keep them foursquare with reality, and then harden into "unreal" dogma. This strikes me as an untenably untheoretical understanding of theory. "Science has achieved its 'exalted' status," Love continues, "because it has, through submitting itself to the rigors of its methodology, been successful in discovering something of

how nature works" (70). Even if one were to grant the veracity of this claim, it would not follow that Marxism or psychoanalysis or structural linguistics or feminism or deconstruction or multiculturalism was thus rendered "anti-scientific." On the contrary, most of these non-scientific intellectual movements emerged precisely through some incisive adaptation of natural scientific methodology or knowledge to cultural objects. Love's sweeping polemic just sweeps too much historical and doctrinal detail under the rug, and in doing so violates his own call for a "rational" assessment of the available "evidence."

For instance, Love contrasts to his image of self-correcting scientific rigor "our own field," that is, literary studies, in which "overstating the evidence or obfuscating reality often enjoys a free ride, if it matches the prevailing orthodoxy" (71). I suppose the grass is always greener in a biology department. However, these characterizations do not inspire confidence in his grasp of the complexities involved in either scientific or cultural/discursive practices. Love states: "There is only one scientific method, and without it science is indeed nothing but the culture-bound activity that its detractors portray" (70). Philosophers of science will be surprised to learn that their longstanding and ongoing debates over a wide range of methodological issues have been resolved into "oneness." Many other practitioners of science studies will also be surprised to learn that their efforts to view the sciences within the contexts of other human pursuits "detracts" from rather than enriches their value and significance.[4] Levin's response to this theoretical constriction in Love's argument is well stated:

> the problem implicit in Love's narrow formulation of a scientific method that somehow transcends the taint of cultural interest should be apparent to anyone concerned with the future of the environment: what is the relationship between the "pure science" of impartial, objective investigation and the frequently unexamined "progressive" assumptions about science and technology implicit in our culture of seemingly endless modifications and interventions? (2)

One way to approach this problematic relationship between the supposed "purity" of science and its wider cultural fingerprints is by reference to a notion borrowed from sociological theory, the concept of scientism. Simply put, scientism is the appropriation of science within a non-scientific context. By this definition, the major trends of cultural or non-scientific theory and practice in the last two centuries have been "scientistic." This can turn out fairly well—as in, say, the discursive legacies of psychoanalysis and structural linguistics—or wretchedly, as in social Darwinism or eugenics—or somewhere in between, as in Mary Baker Eddy's "Christian Science," Frederick

Winslow Taylor's "scientific management," and the other "seemingly endless modifications and interventions" prompted by technoscientific rationalizations. Much depends on whether the application or adaptation of scientific elements is plausible—having some intrinsic and demonstrable purchase on the objects in question, or just for show—an effort merely to purchase social or intellectual validation. The more typical derogatory connotations of scientism reflect this latter expectation of social inflation.

Scientism is generally conceived as a one-way outflow and demotion from a privileged scientific source: "Scientism is present where people draw on widely shared images and notions about the scientific community and its beliefs and practices in order to add weight to arguments they are advancing, or to practices they are promoting. . . . Those who use scientistic language acknowledge and respect *the authority of the scientific community,* and wish to capitalize on that authority. . . . In so doing, they reinforce and consolidate that authority" (Cameron and Edge 3). Defined in this manner, scientism is preeminently a rhetorical device, one that often succeeds in cloaking both its rhetorical nature and its desire for cultural authority behind a borrowed façade of "scientific objectivity."[5] Viewed from this perspective, Love's polemic is plainly scientistic in the latter sense. The nominal epithet "anti-science" as applied to "literary theory" is a stark attempt to rally his reader's support by wrapping his own arguments in the folds of "science," to "capitalize on that authority," and by extension to buttress humanistic discourse on the basis of its presumed association with "real" scientific virtues such as reason, evidence, and common sense: "Let me admit at the outset—if the use of words like *rational*, *evidence*, and *common sense* has not already tipped you off—that I find myself siding with the scientists more often than my fellow humanists" (66). Levin has already indicated how such pronouncements "reinforce one, decidedly narrow kind of science and in doing so to submit the earth and its inhabitants, human and nonhuman alike, to a regime all the more tyrannous for disclaiming any specific interest or partiality toward the 'objects' of its investigation. This is why so many literary critics trained in theoretical and cultural studies have been drawn to those sciences that are in themselves critical of the more narrowly scientistic dimensions of scientific practice, from theoretical physics to systems theory" (2-3).

To me, however, the most poignant part of Love's article is its candid revelation of the plight of mainstream humanism in a technoscientific age. We literary academics flail ourselves because we know from the inside but are unwilling to confess the profound subjectivity of our private preferences, the sheer contingencies of our "tex-

tual evidence," and the deplorable lack of common sense it takes to pursue a career in this field. No wonder that we're bipolar when it comes to the sciences! When we are not resenting "science's position of power and prestige in the academy" (Love 69), projecting upon scientists all the phallic moxie that we ourselves are personally or institutionally deprived of, we are overestimating and idealizing the practice of science as some sort of pure and godlike pursuit rather than the laudable but fallible human institution that it plain and simply is. Love would resolve this crisis of humanistic professional validation by scapegoating and demonizing "literary theory" for its presumed arrogation of intellectual power and specious presumption of the cultural authority to "attack" science! Love's litany seems a trifle obsessive, as if one had stumbled into some sort of academic Beirut. All on one page we read of "attacks upon science," "anti-science attacks from the academy," and for good measure, "cultural constructionist attacks upon science" (66). The urgency of his pro-science crusade against the "anti-science" jihad, Love informs us, is that "clearly the broad public support for science is threatened by such assaults" (66)! It would be helpful to be provided with some *evidence* for such a threat, because the only thing clear to me in all this *Sturm und Drang* is that the literary academy persists in beating up on itself. Perhaps it's time to turn the volume down.

Let me suggest another perspective on this theory business. Were ecocritics to move beyond the monolithic view of theory evidenced in Love's article, and beyond a certain neglect of non-Anglo-American materials, they would find that the most cogent and informed critiques of postmodernist excesses are to be found among the "theorists" themselves. Consider some passages from an important and outspoken thinker who has been unfairly treated as a whipping boy by the anti-theory crowd, French sociologist of science Bruno Latour, in his highly invigorating work *We Have Never Been Modern*.[6] Here Latour characterizes intellectual modernity through the trope of the "modern Constitution" (or at times, "modern settlement"), an unwritten but deeply inscribed epistemological charter in place since the seventeenth century, that is, since Bacon, Newton, and Boyle. Coeval with the emergence of modern science, the modern Constitution has mandated the complete ontological separation of Nature and Society, the nonhuman object and the human subject. Latour terms this the "work of purification." Under the modern Constitution, the subject of science has removed the object of science to a separate ontological realm and so confirmed the absoluteness of "his" objectivity as a non-contingent consciousness possessing stable knowledge of pure objects.

Paradoxically, however, the modern polarization of subject and object has only multiplied the "networks" of "quasi-objects" Latour terms the "hybrids, half object and half subject, that we call machines and facts" (117), and which, although disavowed or repressed as such, have always mediated and continue to mediate between nature and society. Thus, in short, we are led to the predicament we face today, in which reactionary essentialists futilely duke it out with nihilistic postmodernists. Latour's arguments are powerfully driven by the recognition of and desire to resolve this intellectual impasse. They offer a way of conceiving the "social construction" of the grievous schism between the natural world and human society, which ecocritics also desire to overcome, in order to reconstruct a more viable human/nonhuman world. Equally to the point, he does so without grandstanding or scapegoating. His very point is to move beyond the culture of denunciation that poisons the well of modern convictions.

Here is Latour on postmodernism, with special reference to Jean-François Lyotard and Jean Baudrillard: "Postmodernism is a symptom, not a fresh solution. It lives under the modern Constitution, but it no longer believes in the guarantees the Constitution offers. It senses that something has gone awry in the modern critique, but it is not able to do anything but prolong that critique, though without believing in its foundations. Instead of moving on to empirical studies of the networks that give meaning to the work of purification it denounces, postmodernism rejects all empirical work as illusory and deceptively scientistic" (46).[7] I think that many ecocritics would agree with this assessment of the dead end to which one is conducted by certain postmodernist positions. However, they may also find themselves somewhere in the midst of the clash between the "humanists" and the "scientists," which Latour brilliantly satirizes in terms of the strife between the "antimoderns" and the "moderns":

> What do the antimoderns do, then, when they are confronted with this shipwreck? They take on the courageous task of saving what can be saved: souls, minds, emotions, interpersonal relations, the symbolic dimension, human warmth, local specificities, hermeneutics, the margins and the peripheries. An admirable mission, but one that would be more admirable still if all those sacred vessels were actually threatened. Now where does the threat come from? . . . Well, in part from the antimoderns themselves, and from their accomplices the moderns. . . . "You are disenchanting the world; I shall maintain the rights of the spirit!" "You want to maintain the spirit? Then we shall materialize it!" "Reductionists!" "Spiritualists!" The more the antireductionists, the romantics, the spiritualists seek to save subjects, the more the reductionists, the scientistics, the materialists imagine that they possess objects. The more the latter boast, the more they frighten the former;

> the wilder the former become, the more the latter believe that they themselves are indeed terrifying. Are not most ethicists busy with these two opposite but symmetrical tasks: defending the purity of science and rationality from the polluting influence of passions and interests; defending the unique values and rights of human subjects against the domination of scientific and technical objectivity? (123-24)

Latour's discourse allows us to reframe the issue of postmodernism by reference to the strife between traditional humanism, or "antimodernity," and the modern condition per se, precisely as that is determined by the advent of modern science and its assumption of the cultural authority traditionally reserved to religious institutions. Nietzsche having already announced the death of God, postmodernism in its most nihilistic mode issues forth as an annihilation of "reference." This is the crux of Baudrillard's discourse of *simulation* and the *simulacrum*, where no "original" can any longer be found to stabilize the infinite play of informatic facsimiles. This obviously gives ecocritics the creeps, because among the first things to go in this scenario is God's proxy in a postromantic age, the "natural world." But in a longer perspective, the postmodern *mise en abyme* is simply a logical extension of the vast secularization of the world perpetrated by those noble scientists and their "methods," by which the aura of metaphysical essences and divine origins was relentlessly stripped away from the microcosm and the macrocosm. As part and parcel of the same process, the work of purification mandated by the modern Constitution pried apart the premodern mingling of natural objects and human subjects and manufactured the new secular mystique of scientific "objectivity," but at the price of an "enlightened rationality" that relegated spiritual yearnings and residual intuitions of human/nonhuman connectedness to the realms of irrationality and superstition.

So, how do we get out of this conundrum? How can we regain the world we have lost without relinquishing the knowledge we have gained by losing the world in this way? Clearly the resolution lies neither over the postmodern cliff, which amounts to throwing in the towel on the whole affair, nor down the path of antimodern reaction, which amounts to a futile quest to return to Eden, nor by hewing to the social constructions of modern objectivity, which ideology Latour and many others have shown to be coming apart at the seams. After all, it is the accelerating unraveling of objectivist positivity that is precipitating our current sense of existential and epistemological crisis. Technoscientific breaches in the ontological categories of Western humanism—the cyborgs, the cybernetic couplings of organisms and machines, and hybrids, the biotechnological reworkings of naturally-evolved genomes—have finally flushed the quasi-objects up to ines-

capable view. Bruno Latour's remarkable suggestion in face of the dilemmas thrust upon us by these developments is exquisitely simple. We must take seriously the proposition that *we have never been modern*. What does this mean?

For one, it means "the modern world in its turn is becoming susceptible to anthropological treatment" (8). Such an anthropology of modernity is precisely the burden of Latour's form of science studies. Having exhausted the observation of "primitive" tribal cultures, we return to "civilization" and look in the mirror at our own scientific and technological sub-cultures, the very pinnacles of our modern conceit. Lo and behold, we discover in new-fangled guises the same mediation of quasi-objects—"all those nuncios, mediators, delegates, fetishes, machines, figurines, instruments, representatives, angels, lieutenants, spokespersons and cherubim" (129)—that marked the premodern world. But if this is the case, then the "great divide" between the premodern and modern worlds is revealed as factitious, or more to the point, a fetish. Our modern swelled heads are revealed as little shrunken heads. "We have never abandoned the old anthropological matrix. We have never stopped building our collectives with raw materials made of poor humans and humble nonhumans" (115). With the recognition of our nonmodernity, most importantly, we might also find the means to retain what we cherish about scientific knowledge and at the same time reconceive our relations to the nonhuman environment and factor our embeddedness within the natural world into sustainable ways of life.

Latour calls this rapprochement of nature and society "the Parliament of Things," which is to be convened under a "nonmodern Constitution." His use of constitutional metaphors in this context alludes to the philosopher of science from whom he has also borrowed the term and notion of the *quasi-object*, Michel Serres. I would like to turn briefly to Serres's *The Natural Contract* in order to wind this discussion back to its ecocritical starting point.[8] Latour's nonmodern Constitution is an elaborate refiguring of Serres's "natural contract," which is itself a reworking of the social contract of Rousseau and Enlightenment political philosophy in the face of the contemporary environmental crisis. In the opening sections of *The Natural Contract*, Serres constructs a philosophical view of our irreversibly altered global circumstances, an orbital perspective on the "enormous and dense tectonic plates of humanity," which have "long disturbed the albedo, the circulation of water, the median temperature, and the formation of clouds or wind—in short, the elements—as well as the number and evolution of living species in, on, and under its territory" (16). As a result of the unprecedented build-up of anthropogenic effects on the

natural world, "Global history enters nature; global nature enters history: this is something utterly new in philosophy" (4). Having reached global proportions, the violence we are doing to nature now threatens to be matched by a global response, a kind of terrestrial revenge.

Serres's discursive strategy in *The Natural Contract* operates by constructing the objective frames that enclose subjective conflicts. In the useful jargon of contemporary systems theory, Serres is applying to the form of human conflicts a *second-order observation*. One gets perspective on such confrontations by standing outside them sufficiently to view the total form of the distinctions that cut the warring parties apart. To illustrate this thesis and the method by which he pursues it, Serres cleverly begins the book with a short discussion of Francisco Goya's painting "Men Fighting with Sticks" (Museo del Prado, Madrid): "A pair of enemies brandishing sticks is fighting in the midst of a patch of quicksand. . . . Goya has plunged the duelists knee-deep in the mud," but "the belligerents don't notice the abyss they're rushing into." However, "we see it clearly," because we occupy "a third position, outside their squabble," from which "the marsh into which the struggle is sinking" is plain to view (1).

Serres's depiction of battle at the beginning of *The Natural Contract* offers a nice emblem of the current squabbles in the literary academy in particular and the wider culture in general. Goya's image could symbolize the debate that has moved me to enter the fray defined by Glen A. Love's "science/anti-science" distinction, and I have tried to stand outside that construction, or more precisely, to cross out the purchase of that very distinction. Serres's schemas put these academic skirmishes journalistically hyped as the "culture wars," the "theory wars," and the "science wars" into diminishing perspective by framing them within a more important war, the objective war of human society against the natural world: "What was once local—this river, that swamp—is now global: Planet Earth" (3). For while we slug out the culture wars, in our distraction we all sink deeper into the mire, the degradation of the intellectual as well as the natural environment.

A related strategy in Serres's discursive arsenal is to elicit the recognition of a common adversary. Raising the views of mutual opponents to second-order perspectives can realign previously warring parties on the same side of a new and more crucial distinction. Serres rehearses this strategy at first in the form of *debate*—a "subjective" conflict of opinions or judgments—by indicating the level of tacit agreement that must already be present in order for the debaters to operate their disagreements: "Even more than a common language, debate requires the speakers to use the same words in a sense that is at least related and at best identical. They therefore enter into a preliminary

contract, spoken or unspoken, stipulating the use of a common code. This agreement, most often tacit, precedes the debate or combat" (8). This linguistic contract, the common language and code shared by "subjective" debaters, is a "mutual friend" (9) that is itself party to an "objective" conflict with a "mutual enemy" (9) that threatens at any point to end the debate. This unseen adversary could shut the debate down by rendering it inaudible or unintelligible, just as a nuclear holocaust or an environmental catastrophe would certainly render my disagreement with Glen A. Love entirely moot and trivial: "there can be no verbal squabble if a gigantic noise, coming from a new source, covers up every voice with its static" (8). And the source of this potential noise is precisely the physical world that frames the conflict, but which otherwise lies disregarded outside the social world of the adversaries.[9] A sketch of Serres's diagram of debate might look like this:

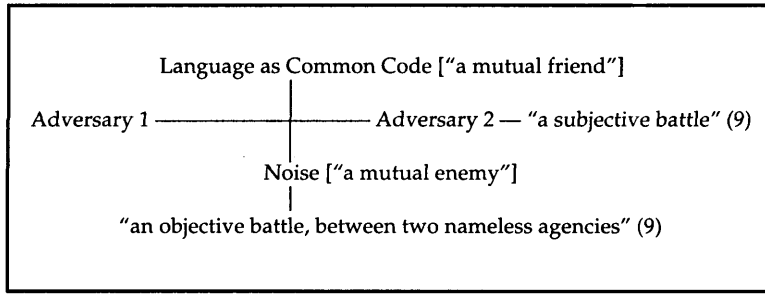

Figure 1. The subjective and objective axes of debate

This diagram of the visible and invisible axes of debate reframes "subjective" disputes through reference to the tacit but "objective" cultural and natural conditions that determine them and provide their very conditions of possibility. However, Serres's rehearsal of this framework of debate is just a preliminary exercise. What is ultimately at stake is not verbal but physical conflict, not social wrangling but *war* and its material destruction of the natural environments that suffer it:

> We never speak of the damage inflicted on the world itself by these wars. . . . I will call *subjective* wars those, whether nuclear or conventional, that nations or states fight . . . I will call *objective* violence that in which all the enemies, unconsciously joined together, are in opposition to the objective world, which is called, in an astonishing metaphor, the "theater" of hostilities. Thus the real is reduced to a spectacle in which the debate stands out against a cardboard backdrop that can be displayed or dismantled at will. . . . Objective violence comes to blows without any preliminary contract. . . . Every battle or war ends up fighting against things, or, rather, doing them violence. (10-11)

Serres's diagram of war, as extended from his diagram of debate, could look like this:

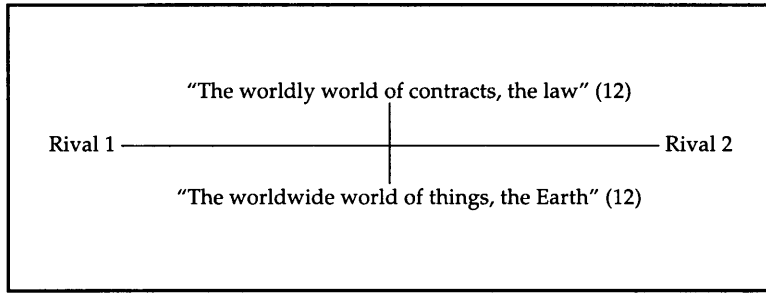

Figure 2. The subjective and objective axes of war

At the beginning of our history, tacit contracts were established to regulate the "subjective wars" of humans against humans by transforming random violence into the legal states of war and peace. Indeed, without such social contracts, we would have wiped each other out aeons ago. In a profound cultural adaptation of natural selection to philosophical speculation, Serres writes: "Before or beside this contract, in the otherwise limitless unleashing of pure and de facto violence, foundational and without end, groups constantly ran the risk of extinction, because vengeance begets vengeance and never stops. The cultures that did not invent these procedures for limiting the duration of violence have been erased from the face of the earth and can no longer testify to this danger" (13). The crux of Serres's thesis throughout *The Natural Contract* is that at the present moment, it is as if we were once again at the dawn of history. As if we had never even been premodern, we are once again in a perilous situation of *unregulated* violence that threatens us with extinction. But the conflict at hand is no longer merely subjective. It has become objective, because the crucial adversarial confrontation does not pit one local group of human subjects against another, but all of humanity against the things of nature altogether. Thus a new pact must be "signed" to bring about an armistice in the "objective wars" between the "worldly world" (*le monde mondain*) of human societies and the "worldwide world" (*le monde mondial*) of the natural environment. In order to ensure that we humans continue to have a history, we must bring "global nature" once and for all into history. We must enact and honor a *natural contract*.

To return to Jonathan Levin's response to Glen A. Love: Levin devotes the major portion of his discussion to *systems theory*, which "despite the many odd mutations it has undergone over the past several decades, also offers new ways of thinking about the relationship between cultural values and the physical and biological conditions in

which they arise" (3). Michel Serres and Bruno Latour are certainly to be included among those who have brought systems-theoretical thinking to bear on their work at the intersection of technoscience with the social sciences and the humanities. In *The Natural Contract* Serres refers explicitly to systems theory and its sister discipline cybernetics in discussing the need to constitute some global feedback loops to ensure a balance between social systems and natural systems (see 37, 43). In the volume Levin cites as a useful introduction to the topic, Fritjof Capra's *The Web of Life: A New Scientific Understanding of Living Systems*,[10] these aspects of systems theory are well discussed in an ecological context, and they concern an issue of prime concern in the early discourse of cybernetics, *homeostasis*, or the use of "governors" (< *cybernetics*) such as thermostats and other servo-mechanisms to maintain steady performance, especially in mechanical systems. This aspect of early-cybernetic systems theory is implicit in Levin's mention of "steady-state systems" (6), as a macroeconomic model ecologically preferable to the unbridled growth scenarios backed by the "progressivist" economic scientisms that presently hold all the sociopolitical cards in the postindustrial nations.

Curiously, Levin's sketch of systems theory focuses on Ernst Mayr, Alfred North Whitehead, and John Dewey—whose work is relatively peripheral to systems theory but which suggests interesting analogues to systems-theoretical thinking—rather than on the mainstream specifics of the scientific history Capra's narration makes readily accessible. It is the transdisciplinary framework of cybernetic ideas—the gathering of physics, chemistry, mathematics, information theory, and computer science together with biology and the cognitive sciences, in the work of Warren McCulloch, Norbert Wiener, John von Neumann, Gregory Bateson, Heinz von Foerster, Ilya Prigogine, Humberto Maturana, and Francisco Varela—that has given rise to the contemporary paradigms of dynamical systems theory, self-organization, and autopoiesis. And it is these developments in their interactive entirety that hold the promise Levin and Capra want to celebrate, of superseding the residual mechanism, naïve positivism, and atomistic reductionism of "progressivist" technoscientism with a more "holistic" ecological recognition of the biospheric interconnectedness of the natural world.

However, if one grants that systems theory yields models of scientific theory and practice superior to earlier paradigms, then one must also reformulate one's epistemological frameworks accordingly. This brings us, finally, to the much maligned concept of *constructivism*. Systems theory replaces idealism's transcendental/empirical distinction (Kant) and positivism's subject/object distinction (Comte) with the distinction between *system* and *environment*,

a development that bears some pondering by readers of a journal devoted to literature and the environment. And this *distinction* between system and environment is one that, without exception, every viable autopoietic system must *construct* for itself in order to come into existence as a system, living or otherwise. Physical, biological, technological, psychical, and social systems are bound together by a common edict to construct boundaries between themselves and their environments and to maintain those distinctions by operating recursively or self-referentially, that is, in such a way as to continuously recreate those constructions.

The operational closure of any autopoietic system—its inability to operate with any elements other than those that it has created by its own operations—marks the self-referential nature of systems, and also accounts for the fundamental impossibility of *knowing* one's environment on any terms other than those that one (or one's interpenetration with other cultural systems) can supply out of their own functioning. This observation is obviously intended not to demote environmental considerations—nor to "attack science"!—but rather, to articulate a systems-theoretical rationale for the very difficulties involved in turning the attention of human societies toward environmental issues. This paradoxical systems-theoretical "strange loop" between openness and closure was elegantly expounded a quarter-century ago by Francisco Varela in an interview published in *CoEvolution Quarterly*. The interviewer asked: "So studying the organization of a whole system is studying the nature of its self-reference?"

> Varela: That's it. That is, [it is studying] the kind of self-referential organization that has provided the stable properties that [a whole system] shows. And this is what gives the system its nature. When you have a closed interaction of chemical properties, you can have a cell, and not before that. When you have a closed interaction of descriptions, you can have self-consciousness, and not before. When you have a closed interaction of species, you have an ecological system, and not before. That is, the closure, the self-referential-ness, seem to be the hinges upon which the emergent properties of a system turn. (Valera and Johnson 26)[11]

In short, systems theory tells us that autopoietic systems, in nature and in society, construct their own reality. Or as Margulis and Sagan develop this theme in *What is Life?*, life itself has to construct the conditions for its own evolutionary autopoiesis. All that constructivist epistemology says is that the brains and minds by which we do science and philosophy and the social organizations by which we pool our human emotional and intellectual resources enjoy no transcendental or positivistic absolution from these pro-

cesses. As social-systems theorist Niklas Luhmann writes: "Brain research has shown that the brain is not able to maintain any contact with the outer world on the level of its own operations, but—from the perspective of information—operates closed in upon itself. This is obviously also true for the brains of those engaged in brain research" ("The Cognitive" 64).[12] In his mordant way, Luhmann is asking for a scientific epistemology that confronts head on the paradoxes of self-reference thrust upon us by the autopoietic construction not just of our bodies and the interwoven systems of living organizations but also of our minds and the societies in which they are cultivated: "Whoever still maintains that knowledge is the construction of a relation to the environment that fits things as they are, is welcome to his opinion but he is forced to begin his theoretical reflections with a paradox: it is only non-knowing [i.e., operationally closed] systems that can know; or, one can only see because one cannot see" (67). Scientific observers must see that they cannot see what they cannot see, the blind spot where systems of observation loop in on themselves.

When the resources cease for maintaining operational or informatic closure *within* systems, in the midst of their material-energetic flux and commerce with the environments *without* that they themselves create, systems cease.The science warriors Love applauds, who seem to think that they can bring the cosmos bare-handed into their brains without collapsing the very membrane between mind and nature that enables them to think scientific thoughts in the first place, are trying to prop up an obsolete scientistic paradigm on the verge of losing the resources to maintain its pattern, its ideological autopoiesis. Serres's *The Natural Contract* signals the following terms of truce: "Peace then between the friends of forms and the sons of the Earth, between those who pronounce the law and those who are attached to the land, peace between the separated brothers, between the idealists of language and the realists of things themselves, and let them love one another. There is nothing real but love, and no other law" (50). What you despise is the intimate obverse of what maintains you in being. Land and law overlap, nature and society loop into each other with a self-referential twist. Simultaneously divisionary and reintegrative, systems theory reorganizes the social communications between scientific and religious motives.

NOTES

1. Glen A. Love's "Science, Anti-Science, and Ecocriticism" appeared in *ISLE* 6.1, and Jonathan Levin's "Between Science and Anti-Science: A Response to Glen A. Love" appeared a year later in *ISLE* 7.1.

2. Spun off from a Modern Language Association discussion group in the mid-80s, the Society for Literature and Science holds an annual conference and sponsors the journal *Configurations* and, in association with the University of Michigan Press, the series Studies in Literature and Science.

3. "Science is asymptotic: it never arrives at but only approaches the tantalizing goal of final knowledge." Lynn Margulis and Dorian Sagan, *What is Life?* (3).

4. A balanced rehearsal of these issues is David J. Hess, *Science Studies: An Advanced Introduction*. To sample the harder stuff, look into Bruno Latour and Steven Woolgar, *Laboratory Life: The Construction of Scientific Facts*, Bruno Latour, *Science in Action: How to Follow Scientists and Engineers through Society*, and with particular reference to the construction of natural history, Donna Haraway, *Primate Visions: Gender, Race, and Nature in the World of Modern Science*.

5. See Casper Hakfoort, "The Historiography of Scientism: A Critical Review" (387).

6. In pointed response to his manhandling in the science wars, see Bruno Latour, *Pandora's Hope: Essays on the Reality of Science Studies*. Readers of *ISLE* might be especially interested in his long chapter "Circulating Reference: Sampling the Soil in the Amazon Forest" (24-79).

7. By empirical studies Latour is implicitly alluding to analyses of "science in action" such as Latour and Woolgar, *Laboratory Life*, and Latour, *Science in Action*.

8. See also Michel Serres with Bruno Latour, *Conversations on Science, Culture, and Time*, and Maria L. Assad, *Reading with Michel Serres: An Encounter with Time*, esp. "Time and Earth: Reading *Le Contrat naturel*" (149-62). Recent symposia devoted to Serres's work are the special issues *An Ecology of Knowledge: Michel Serres*, ed. Sydney Lévy, and *Michel Serres*, ed. Pierpaolo Antonello and Robert P. Harrison.

9. Serres is here reworking his previous discussions of noise and dialogue in order to carry them toward environmental issues. See in particular the back-to-back chapters "Platonic Dialogue" and "The Origin of Language: Biology, Information Theory, and Thermodynamics," *Hermes: Literature, Science, Philosophy* (65-83).

10. On feedback mechanisms and homeostasis, see Capra (56-64).

11. For detailed treatments of the formalisms suggested by this interview, see Francisco J. Varela, *Principles of Biological Autonomy*, and as extended to social-scientific and humanistic scholarship, Dirk Baecker, ed., *Problems of Form*. See also Humberto R. Maturana and Francisco J. Varela, *The Tree of Knowledge: The Biological Roots of Human Understanding*.

12. See also Niklas Luhmann, *Ecological Communication*, and *Essays on Self-Reference*; Cary Wolfe, "Systems Theory: Maturana and Varela with Luhmann," in *Critical Environments: Postmodern Theory and the Pragmatics of the "Outside"* (40-83); and William Rasch and Cary Wolfe, ed., *Observing Complexity: Systems Theory and Postmodernity*.

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