Articles

Toward an Ecological Civilization: The Science, Ethics, and Politics of Eco-Poiesis*

Arran Gare

Arran Gare is associate professor (Reader) in Philosophy and Cultural Inquiry, Swinburne University, and founder of the Joseph Needham Centre for Complex Processes Research. He is the author of *Postmodernism and the Environmental Crisis* (London: Routledge, 1995) and *Nihilism Inc.: Environmental Destruction and the Metaphysics of Sustainability* (Sydney: Eco-Logical Press, 1996). He is a founding editor of the online journal *Cosmos and History.* E-mail: <agare@swin.edu.au>.

Abstract: Chinese environmentalists have called for an ecological civilization. To promote this, ecology is defended as the core science embodying process metaphysics, and it is argued that as such ecology can serve as the foundation of such a civilization. Integrating hierarchy theory and Peircian semiotics into this science, it is shown how "community" and "communities of communities," in which communities are defined by their organization to promote the common good of their components, have to be recognized as central concepts not only of ecology, but of life itself. This perspective is used to defend Lovelock's "Gaia" hypothesis and the call of Prugh, Costanza, and Daly for strong democracy. An ethics and political philosophy is sketched based on "eco-poiesis" or "home-making," which is equated with augmenting the life of communities, both human and non-human.

The Austro-French ecological Marxist, André Gorz, began the first chapter of his book *Paths to Paradise* by noting:

> Times of crisis are also times of great freedom. Our world is out of joint; societies are disintegrating, our lifelong hopes and values are crumbling. The future ceases to be a continuation of past trends. The meaning of present development is confused; the meaning of history suspended. Because the curtain has fallen on the old order and no other order waits in the wing, we must improvise the future as never before. Those who propose a fundamentally different society can no longer be condemned in the name of realism. On the

> contrary, realism now consists of acknowledging that "industrialism" has reached a stage where it can go no further, blocked by obstacles of its own making. . . . The direction of our escape from the crisis is the fundamental issue. It depends on political, technological and cultural choices—choices which we must now make. (1)

This was written in 1983, during an earlier economic crisis, when people were just becoming aware that the global ecological crisis was threatening the very existence of humanity. Gorz's proclamation was not heeded. The subsequent path taken was of intensified exploitation of nature, farmers, and workers, driven by the quest for profits, with almost no regard for ecological constraints. At the same time, the command economies of Eastern Europe collapsed, being totally discredited as alternatives to market-based economies. While enriching some to a fantastic degree, this profit driven economic growth impoverished vast numbers of people, brought us to the greatest economic crisis since the Great Depression, and to the brink of ecological disaster. This situation makes Gorz's call for radical choices more apposite than ever. The current economic crisis should be seen as an opportunity to chart a new course for humanity. So radical is the change required to address this ecological crisis that it is not too dramatic to characterize what is required as the creation of a new civilization. As was originally called for in 1984 in the former Soviet Union, then in 1987 by Ye Qianji in China, we need to create an "ecological civilization" (Xu 158f.). The notion of ecological civilization was promoted by Yue Pan, deputy director of China's State Environmental Protection Administration (SEPA), incorporated into the Communist Party of China's Central Commission Report to its 17th Convention in November 2007, and embraced as one of the key elements in its political guidelines (Huan 9). The world should follow the lead of China.

To begin with, however, it is first necessary to clarify the seriousness of the situation confronting us. The most serious problem, although by no means the only one, is global warming. The challenge posed by this greatest of all problems highlights the importance and inter-relatedness of almost all other ecological problems, and the obstacles standing in the way of addressing this problem illuminate the difficulty in taking effective action to address any ecological problem. Gaia Vince, in a recent edition of *New Scientist,* attempted to portray what the Earth would look like if the world were 4ºC warmer ("Surviving" 28-33). A map showed most of the presently populated world, including almost all of China,

the U.S., Africa, South America and Australia, to be uninhabitable desert or uninhabitable due to floods, drought, or extreme weather. But if the world does heat up to this extent why should it stop there? There will be so many positive feedback loops set in motion that James Lovelock, reflecting on what happened in the Eocene ecological collapse of 55 million years ago, concluded that things will get far worse (Pearce). He shocked people by suggesting that our inability to address this crisis will leave as few as two hundred million people alive at the end of the century, living close to the North Pole (Powell). In suggesting this, Lovelock claimed to be an optimist, and many scientists agree with him. As Gwynne Dyer has pointed out, food shortages generated by global warming will result in major wars, devastating much of the world. How could so many people survive the violence and social disintegration such a catastrophe would unleash? What we seem to be facing is a collapse of civilization due to ecological destruction, as has occurred a number of times in the past, in which the few survivors, if there are any, will live with cruder cultures in small, self-sufficient communities in the few places still habitable (Chew *Recurring*; see also McIntosh, Tainter & McIntosh; Diamond; and Tainter). This is the destiny of humanity unless there is radical change.

Diverse proposals have been put forward to deal with this. James Hansen (the eminent climate scientist from NASA) and his wife, in an open letter to President Obama and his wife, characterized policies such as the Kyoto Protocol, as "ineffectual and not commensurate with the climate threat." They continued:

> There is a profound disconnect between actions that policy circles are considering and what the science demands for the preservation of the planet. . . . Science and policy cannot be divorced. It is still feasible to avert climate disasters, but only if policies are consistent with what science indicates to be required. (2)

They argued for a moratorium and phase-out of coal plants that do not capture and store CO_2, and raising the cost of carbon emissions via a greatly increased carbon tax. They also called for urgent research and development of fourth-generation nuclear power with international cooperation. Vandana Shiva is equally concerned about the inadequacy of current government policies, but does not see the solution in nuclear power—which she regards as the dirtiest of all the "new clean fuel" options. Promoting "Earth Democracy," she is calling for local control of food production, nutrition, and soil health, defending and recreating

traditional forms of farming and ways of life. These are the ways of farming which are sustainable, she argues. They preserve diverse forms of life, including forests, and do not use up resources or generate massive greenhouse gas emissions.

Other environmentalists call for even more radical thinking. Lovelock calls for a mobilization of humanity equivalent to preparation for war, promising nothing but blood, sweat, and tears, radically changing our outlook on life and the way we live. Instead of fouling our own nests, we must create a civilization that exalts and augments the life of Gaia, the global ecosystem. In the immediate future this will involve taking on the massive task of not merely ending greenhouse gas emissions but also "geo-engineering," utilizing living processes to restabilize the gobal ecosystem. He has defended the use of nuclear power, but now sees this as inadequate. Our last hope is to bury vast amounts of charcoal produced from farm waste, removing carbon from the atmosphere by taking it out of circulation (Vince, "Doomed"). Thomas Prugh, Robert Costanza, and Herman Daly see a different problem, the unattractiveness of the life promised by most environmentalists. As they put it:

> There seems to be only two visions put on the table. In the conventional vision, the human economy and population keep growing vigorously, and everyone eagerly chases the dream of greater consumption. The environmentalist point of view rightly denies the workability of this vision but offers in its place a kind of lifelong global celery diet. It is hardly surprising that most people choose the first path. (41)

Their concern is to promote a form of life and way of thinking that will inspire people to work for the common good. They call for strong democracy, countering the concentrations of power in the hands of global corporations.

These responses exemplify the major orientations to the ecological crisis. Hansen, as one would expect of a scientist working with NASA, puts his faith in market manipulation and technological fixes. He is particularly concerned to promote further research into these fixes. He typifies the attitude of those who accept industrial civilization and seek for answers that build on and extend its achievements. Shiva, who began her career as a physicist, is an exemplary case of someone who has lost faith in industrial civilization and is concerned to expose most of its apparent achievements as illusions, and to show the superiority of earlier

social forms. Effectively she is a defender of an agricultural civilization that industrial civilization is destroying. Lovelock, originator of the "Gaia hypothesis" according to which the Earth is a living organism in the sense that, through feedback mechanisms involving its living components, it produces and maintains the conditions for these components, adapting to perturbations and external changes,[1] and Prugh, Costanza and Daly, founders of ecological economics,[2] are more complex. They are sympathetic to earlier social forms and critical of industrial civilization, but are struggling to create something new. Embracing and advancing ecology in radically new directions, they can be seen as advancing beyond industrial civilization. They are harbingers of the new, ecological civilization.

How can we evaluate these orientations? While it would seem difficult to deny that technological advances generated by industrial civilization have solved one problem after another and united humanity into one civilization,[3] at the same time for every problem that has been solved a plethora of more serious problems has been generated. Shiva is surely right to point out that modernist forms of technology, particularly as applied to agriculture, have been associated with the concentration of economic power, excluding and impoverishing much of humanity, and it is precisely this which has damaged local and global ecosystems. Her views on this have found strong theoretical and empirical support in Alf Hornborg's book, *The Power of the Machine.* More broadly, she is surely right to see recent drives for modernization based on neo-liberal ideology as a new phase of imperialism. Furthermore, imperialism has been inseparable from industrial civilization, particularly in its capitalist form, from its beginning. The success of her movement in preserving and reviving traditional Indian forms of agriculture is a powerful challenge to the assumptions of modernists. However, is the hostility to industrial civilization in general, and to nuclear power, entirely justified? The far higher life expectancy of people in industrial civilization compared to agricultural civilizations suggests some real successes, and as Lovelock argued, the replacement of coal-fired power generators by nuclear reactors could give us the time necessary to avoid disaster, even if it is not enough by itself (*Vanishing* 68-76).

Daly and Cobb have made the same point as Shiva by noting that the Amish communities in the U.S., which eschew most modern technology, are flourishing, while most other farmers are going bankrupt (273, 280). But at the same time, they can see that people in developed economies

are not going to revert to simple agrarian subsistence farming, and they are appreciative of developments in post-mechanistic science, particularly ecology. They are struggling to redefine the meaning of progress in a way that takes into account ecology and which upholds an attractive vision of life that people will be willing to strive for. Extolling strong democracy in which people define themselves through their citizenship of democratically organized communities, that is, as governors of their communities with all the responsibilities entailed by this, rather than as consumers, does appear promising. And where there is strong democracy, such as in Switzerland and Sweden, people are far less ecologically destructive than in countries dominated by consumer capitalism (producing less than a third per capita of the greenhouse gas emissions of Americans, Canadians, or Australians), and are making more concerted efforts to deal with environmental problems. However, global warming is a global problem in which the whole of humanity is involved, both as perpetrators of environmental destruction and as victims of its effects, and dealing with the dynamics of the global economic system presents immense problems for those attempting even to maintain what democracy there is.

It is in this context that the idea of an ecological civilization, conceived as the successor to traditional agrarian civilizations and industrial civilization, suggests a vision large enough for the magnitude of ecological problems. At the same time, however, it is evident that there are immense problems to be overcome in creating such a civilization, not the least of which is conceiving what such a civilization would be.

What could it mean to create an ecological civilization as the successor to agricultural and industrial civilizations? To answer this question, it is first necessary to examine what is meant by "civilization." "Civilization" originally was defined in opposition to barbarity as both a process and an achieved condition of social order and refinement, having behind it the spirit of Enlightenment with its emphasis on progressive human development (Williams 57ff.). This was the sense in which civilization was understood by environmentalists in the Soviet Union who originated the notion of ecological civilization. They meant by this a further development of humanity to take into account the ecological conditions of our existence. However, the notion of "civilization" also developed a further meaning. The plural "civilizations" came to be used to acknowledge the diversity of forms of social order and refinement in history, attracting adjectives such as "Greek" civilization, "Roman" civilization, "Chinese"

civilization, "Medieval" civilization, "Modern" civilization, and "Western" civilization (Braudel 3-8). To call for an ecological civilization in this sense is to call for a more dramatic transformation. In referring to agricultural civilizations, industrial civilization, and ecological civilization, I am suggesting that it is this more dramatic sense of transformation that is required, but at the same time this transformation should be seen as incorporating what was best in industrial civilization and in agricultural civilizations. The problem then is to work out what identifies a civilization and, more importantly, the transformation of one civilization into another; and what is the relation between the old and the new civilizations.

The difficulties here are evident in the overlapping of identities. For instance, European civilization might encompass Greek, Roman, Medieval, and Modern civilizations, and be characterized in opposition to Chinese civilization, which in turn might be seen to encompass the civilizations of the different dynasties, not to mention different economic, political, and spiritual civilizations. Such overlapping identifies should appear less problematic when it is appreciated that "civilization" is a noun of process. This implies that these are durational processes with a narrative identity rather than the absolute identity of an object, and it is possible for processes to be co-extensive, even contributing to each other, while being different with different dynamics. There is still the problem of what constitutes a civilization as a civilization, however. My contention is that "civilizations" are characterized by deep assumptions about the nature of the world and the place of humanity within it, and thereby the ultimate ends worth striving for. These assumptions permeate all domains of culture, including practices and institutions, and are reproduced over long durations by the practices and forms of life embodying and expressing these deep assumptions. Civilized societies differ from uncivilized societies in the complexity and coherence of their cultures and ideals and thereby in the degree of complexity of their organization, and, most importantly, the degree of cultivation of its members required to uphold these ideals and to participate in these complex societies. The reason why it makes sense to talk of European civilization and still distinguish Greek, Roman, Medieval, and Modern civilizations is that there is some continuity in deep assumptions and ideals in the evolution of Europe from Greek civilization to modernity, and yet there were still major transformations of these assumptions and ideals which affected every aspect of the thinking, ways of living and organization of Europeans. It is possible to talk of agricultural civilizations

because, being based above all on practices and developments of agriculture, these civilizations tended to develop similar forms of thinking and organization and yet developed largely independently of each other and still had very distinctive characteristics and ideals. Industrial civilization, on the other hand, while originating with the civilization of Modern Europe, dramatically transformed every other civilization in the world since these had to embrace industrial civilization to defend themselves against Western imperialism. In this way industrial civilization, associated with a drive to reduce the whole of nature to an instrument serving human purposes and the forced imposition of a global market, has united the world into one civilization, although there are major differences within it reflecting the influence of preceding civilizations, and there are still relics of earlier ways of life which have not yet been entirely dissolved by industrial civilization. Ecological civilization as a global civilization could only emerge from a world-order which had already been united by industrial civilization, but it will transcend and radically transform this civilization. It will involve a transformation in deep assumptions, ways of thinking, and ultimate aspirations, in ways of living and organizing society just as great as that which occurred with the birth of agricultural civilizations, or the birth of Chinese civilization, Greek civilization, or Modern industrial civilization, and yet it will preserve and sometimes revive all that was best in these and other civilizations, allowing for diversity and difference and the preservation of the identities of previous civilizations.

What are these deep assumptions and ways of thinking which could form the basis of a new civilization? While having deep roots in past traditions of thought, these are the ways of thinking being advanced and integrated by the science of ecology. Ecological science is a fundamental challenge not only to the core assumptions of modern science, but of industrial civilization. Acceptance of ecology will involve not merely a transformation of science, but a transformation of the relationship between science and other domains of culture, impacting on people's lives, their institutions, and their organizations, and more fundamentally, on their image of the future and of the ultimate ideals and goals worth struggling for. By "modern" science I mean the form science took with the emergence of industrial civilization, that is, a form of reductionist materialism that denied any purpose to human existence, rendered sentient life unintelligible, created a dualism between body and mind, divided science from and opposed it to the arts and humanities, and yet sustained a vision of the

future as the total conquest of nature to serve human purposes, or at least the purposes of the winners in the struggle for survival and dominance. The most potent political expression of reductionist materialism has been economic theory and Social Darwinism, both based on Hobbes' mechanistic philosophy, culminating in neo-classical economics, which has redefined almost all social relations in society as forms of contract between egoists, and all relations to nature as instrumental relations. Recent developments in ecology, while advancing science and thereby building on the most advanced achievements of modernity, provide the basis for overcoming not only the limitations of this way of thinking, but the failures of industrial civilization. These advances provide the basis for making teleology intelligible, making sentience comprehensible, overcoming the dualism between body and mind, and between science and the arts and humanities, and, through situating humanity as an emergent complex of processes and structures within nature, provide the basis for comprehending the achievements and limitations of both industrial and pre-industrial civilizations. In doing so, I will argue, ecology is developing the forms of thinking required to rethink the relationship between humanity and nature and between individuals and their communities, the nature of culture and civilization, and thereby to transform the way people live and organize themselves. It provides the basis for a different vision of the future, with a different kind of ethics and political philosophy than those which have dominated modernity. That is, ecology is developing the forms of thinking required to create an ecological civilization.

Ecology and the global ecosystem: the logic of eco-poiesis

In pondering what appears to be the confused state of ecology, Robert Ulanowicz, a leading theoretical ecologist, claimed that this is because ecology brings into focus what are now coming to be seen as the core problems that have to be addressed to advance science in all fields. Reductionist materialism cannot account for organized complexity or its emergence, and ecology is the field in which such emergence can be studied. As he put it in his book *Ecology, The Ascendent Perspective*:

> Ecology occupies the propitious middle ground. . . . Indeed ecology may well provide a *preferred* theatre in which to search for principles that might offer very broad implications for science in general. If we loosen the grip of our prejudice in favour of mechanism as the general principle, we see in this thought the first inkling that ecology,

> the sick discipline, could in fact become the key to a radical leap in scientific thought. A new perspective on how things happen in the ecological world might conceivably break the conceptual logjams that currently hinder progress in understanding evolutionary phenomena, development biology, the rest of the life sciences, and, conceivably, even physics. (6)

There are a number of elements being integrated in recent developments in theoretical ecology. The most important of these elements are non-linear thermodynamics, hierarchy theory and other developments in complexity theory, and biosemiotics, including eco-semiotics. Such developments involve a new way of understanding the nature of life, and justify Lovelock's Gaia hypothesis, the claim that the Earth itself is alive and has produced the conditions for life. These ideas have then provided the basis for new developments in human ecology, characterizing humanity as a complex of processes and structures within the global ecosystem and providing new insights into why civilizations collapse, and what is required to avoid such collapse.

Some theorists argue that not only should open systems be given a central place, but that rather than taking closed, isolated systems in equilibrium as the standard against which open systems are defined, open systems should be taken as the norm (Rosen, "Order"). Taking this seriously means acknowledging path dependence, taking the history of systems seriously, and focusing on "process variables," such as the flow of heat or electricity rather than the "state variables," which characterize the status of a system when in equilibrium (Rosen, *Life* 67-107 and Ulanowicz, *Third* 41). Thermodynamically open systems, or as Ilya Prigogine characterized them, "dissipative structures," emerge to increase the rate of transformation of useable energy (exergy) into entropy. Such systems, characterized by cyclic flow processes, are to some extent self-organizing. They manifest coherent self-perpetuating behavior that is internally generated, are able to establish states in themselves which persist even when the external environment changes, and are characterized by propensities to develop along particular paths. Their emergence and development involves a form of creative causation, and ultimately, has led to the emergence of us as beings able to understand this.

Acknowledging the irreducibility of complex processes, the reality of creative becoming, and that we are participants in the world that we are trying to understand, requires radical rethinking about the very nature of

physical existence, and what it means to explain anything. As Prigogine and Stengers argued, it requires the acceptance of the process philosophy of Bergson and Whitehead in place of the reductionism of mainstream physics, whether in the form of atomism or unified field theory. And Ulanowicz is now arguing for a "process ecology" which should serve as the foundation for "an ecological metaphysic" (*Third* 115-49). That is, the ultimate existents of the universe have to be seen as creative processes, or durational self-constraining patterns of activity, and configurations of such processes in dynamic interaction, rather than as objects or things. The focus of science should be on processes and chance events, rather than on law, since as Ulanowicz put it: "laws emerged out of inchoate processes eventually to become static, degenerate forms of the latter" (*Third* 164).

However, complexity theory is not so much a unified theory as a unified problem: how to understand organized complexity. A variety of theories have been developed under this name, ranging from largely reductionist approaches dominating the studies of complex adaptive systems of the Santa Fe Institute focusing on the patterns which emerge in the computer modeling of interactions between large numbers of components, to theories radically opposed to all forms of reductionism. It is the latter that are more important for ecology.

One of the most important of these is hierarchy theory.[4] For hierarchy theorists inspired by the work of Pattee, the very being of any system involves self-constraining, and such self-constraining is the basis of the freedom of these systems. As Pattee wrote:

> The constraints of the genetic code on ordinary chemistry make possible the diversity of living forms. At the next level, the additional constraints of genetic suppressors make possible the integrated development of functional organs and multi-cellular individuals. At the highest levels of control we know that legal constraints are necessary to establish a free society, and constraints of spelling and syntax are prerequisites for free expression of thought. (73f.)

To identify hierarchies of constraints it is necessary to identify the different process rates. As O'Neill, et al., in a major work on theoretical ecology argued: "The structure imposed by differences in rates is sufficient to decompose a complex system into organizational levels and into discrete components within each level" (76). Activity corresponding to higher levels operates at slower rates, while lower levels operate at relatively fast rates. Emergence of new systems involves the interpolation of new con-

straints characterized by specific tempos between processes characterized by longer and processes characterized by shorter tempos. Hierarchies are ubiquitous in eco-systems.

Most of the constraints in ecosystems are associated with cycling. As Ho argued, as complex dissipative structures, living systems have two aspects:

> the ubiquitous cycling that occurs at every level of living organization, and the coupling of all the cyclic processes. This is so from the ecological cycle of the biosphere to the biochemical metabolic cycles in organisms down to the whirring of molecular machines, all meticulously choreographed . . . to spin and turn at different rates, each in step with the whole. (53)

However, the key to understanding the thermodynamics of living systems, according to Ho, is "neither energy flow, nor energy dissipation, but energy *storage* under energy flow" (81). Entrained cycles at multiple scales enable these systems to capture usable energy, store it, and utilize it efficiently. As Ho and Ulanowicz put it:

> [C]oordination (organization) . . . depends on how the captured energy is mobilized in cycles, or more precisely, quasi-limit cycles, which can be thought of as dynamic boxes; and they come in all sizes, from the very fast to the very slow, from the global to the most local. Cycles provide the dynamic closure that is absolutely necessary for life. (43)

Through these cycles energy is trapped and circulated, doing work only when required. Efficiency is achieved through coupling of cycles in which "energy yielding reactions are always coupled with energy requiring reactions." According to Ho: "Coupled cycles are the ultimate wisdom of nature" (54).

Understanding the relationship between processes characterized by different process rates allows us to understand teleology or "final causation," and along with this, functionality and control. As Stanley Salthe pointed out: "constraints from the higher level not only help to select the lower-level trajectory but also pull it into its future at the same time. Top-down causality is a form of final causality" (*Development* 270). This can involve a tendency of systems to augment the conditions of their existence, and in doing so, develop functional components serving this end. At whatever scale an ecosystem is examined, it will tend to be "homeorhetic," that is, it will tend to return to its trajectory of development after a perturbation. Such perturbations are by definition outside the system. But such perturbations

can be incorporated into an ecosystem when at a higher level of organization some control over the abiotic (non-living) environment is established, although these perturbations are uncontrolled at a lower level (O'Neill 163 ff.). For instance, forests control to some degree temperature, levels of humidity, and even rainfall that are beyond the control of individual organisms or local ecosystems, so that these become part of a broader, higher level ecosystem. In the resulting stabilized environment, species are selected for their compatibility with other species in this ecosystem rather than with the physical environment, hence strengthening this control.

This can be associated with the development of a new kind of complexity, studied by Rosen, where systems are characterized by multiple dynamical processes each of which is both a component of and at the same time partially, but not entirely, a product of the others (*Life* 108-51 and "Order"). Each is in part an immanent cause of its own existence with its own specific dynamics, and cannot be entirely explained as an effect of the other processes, while at the same time being inseparable from them. Modeling such complex systems requires a new kind of mathematics which takes into account both irreducible diversity and interdependence, and such models cannot be simulated on a computer. In such systems functional components become products of the system and as such are inseparable from the system without being merely the effects of the system. They can only be identified through their functions and cannot be identified with fractionable parts, that is, parts that could exist independently of these systems. For instance, the functional components of a forest are those structures responsible for capturing solar energy, recycling nutrients, and maintaining temperature and humidity. These components cannot be physically isolated; to attempt to do so would destroy them and the system of which they are part.

In developing hierarchy theory, Howard Pattee was particularly concerned to provide a physical account of control, which, he argued, required of systems that they generate models of themselves to achieve such control ("Necessity"). That is, he attempted to account for how physical processes could generate symbols or signs. Through producing and interpreting signs, systems can respond not only to their immediate situation but can anticipate what situations they will encounter in the future. It was soon realized (by Salthe, *Development* 13ff.) that Pattee's ideas accorded with the more radical work of the philosopher Charles Sanders Peirce, who had attempted to develop a general theory of signs

to account for their possibility, and to reveal the extent to which the production and interpretation of signs pervades nature (Gare, "Semiotics" 18ff.). The most general definition of a sign offered by Peirce was that it was that which "mediates between an object and an interpretant; since it is both determined by the object *relatively to the interpretant,* and determines the interpretant *in reference to the object,* in such wise as to cause the interpretant to be determined by the object through the mediation of the sign" (*Essential* 410). It is important to emphasize here "this tri-relative influence" is not "in any way resolvable into actions between pairs" (*Philosophical* 82); that is, this influence cannot be analyzed into cause-effect relations, and involves some measure of creativity in nature. Interpretants can themselves become signs, generating new interpretants, and this process can continue indefinitely. Such semiosis involves limiting of possibilities of the interpretant by the object through the sign, but this is what facilitates some control by a system of its own future.

When people talk of the production and interpretation of signs or semiosis they are prone to think of this first and foremost as "symbolic," as in language where an utterance is made by someone and interpreted by someone else. However, as biosemioticians have argued, far more commonly in nature, interpretants, which in turn become signs for further interpretation, are actions or movements. This is true not only in animals, but also in human semiotic activity. In these cases interpretation is simply an aspect of an action, and such actions are taken as further signs by other actors. Even more fundamentally, as Kalevi Kull has argued, interpretants are secretions or growth of forms, which also become signs for further interpretants (336). Secretions are any release of fluids or gases in response to situations, such as the chemicals that are released by trees in response to pests. These can lead other trees to release these chemicals even before being attacked by the pests. The chemicals function as signs and generate new interpretants. Growth of form, or morphogenesis, such as plant germs growing into plants and embryos growing into organisms, insofar as these are influenced by the genome, is an interpretant. DNA is really a system of signs bequeathed by organisms to their progeny, providing them with instructions on what form will survive in a given environment, and how to "interpret" other signs in this environment (Hoffmeyer, *Signs* 20ff.). It is by virtue of their "interpretation" of their DNA that plants grow down to water and up towards light, utilizing gravity as a directional sign, while responding to

contingencies in their environment. Such morphogenesis, along with secretions, is "vegetative semiosis" (Kull 344). Illustrating this interpretative relationship among DNA, environment, and morphogenesis, the developing embryo of a short-horned grasshopper develops the capacity to interpret signs indicating the kind of environment it will enter into, growing into either a normal grasshopper or a locust. After semiosis associated with cells, "vegetative semiosis" is the most basic form of semiosis. It is presupposed by "animal semiosis" or action, which in turn is presupposed by "symbolic semiosis" (Kull 344ff.). Utilizing the potentialities of physical structures (such as the structures of molecules) while responding to conditions, vegetative semiosis generates a vast diversity of forms or structures, including the growth of colonies of organisms to form larger structures, such as moss, corals, or forests.

Semiosis in ecosystems can and frequently does take place at all levels: cellular, vegetative, animal, and symbolic. For instance, the growth of flowers and their opening, on the basis of their genotype and communication between cells, is a sign to bees, which is interpreted in their activities of collecting nectar, but also in bee dances in their hives by which they indicate to other bees where flowers (if there is a shortage of flowers) can be found. The productive relationship between semiotic levels is demonstrated in the work of J. Scott Turner. His study of termite mounds revealed how termites, responding to local changes in humidity and CO_2 by picking up and moving grains of soil, produce massive functional forms serving the whole termite colony. He showed how "soil transport, mound structure, and gas exchange [are] coupled together in a closed functional loop" to create a steady internal environment that is regulated by the form of the mound produced by such activity. Generalizing from this study, he characterized biological form as "embodied physiology: it is simultaneously structure and function." At the same time "it is embodied homeostasis." In the case of the termite mounds, altered levels of carbon dioxide and humidity, are restored to the original state by the termites. This, Turner argued, "points to designedness—the harmonious matching of function and structure" (27). These forms are not things, nor actions, but something in between; they are "dynamic structures" (21). Turner showed that it is a universal phenomenon of life to partition and create environments upon which homeostasis can be imposed, and he also showed how the vast array of biological forms, from the micro-level to the macro-level, are generated as a consequence.

This work supports the studies of Christopher Alexander, an architect and complexity theorist, who, generalizing from his work on architectural form, concluded:

> The important thing about morphogenesis, in all its biological forms, is that highly complex, ordered structure is created in such a way that it is in balance with its environment. It is not too much to say that the enormous and extensive co-adaptive harmony of organisms in Nature is altogether due to morphogenesis. (12)

Through mutual accommodation of diverse processes, Alexander showed how life generates distinctively living forms characterized by mutually augmenting centers at multiple scales. These can be seen to correspond to the multi-level cycles or "dynamic boxes" characteristic of coordinated systems as described by Ho and Ulanowicz. When the ubiquity of morphogenesis in living processes is appreciated, and it is recognized as vegetative semiosis, it can be seen how morphogenesis plays the central role in the stability of ecosystems, including the global ecosystem, further justifying Lovelock's characterization of the global ecosystem as alive.

So far I have been discussing ecosystems, referring to organisms incidentally. Where do organisms as such fit within this scheme? Organisms can best be understood as highly integrated ecosystems. They are "systems of homes" (the literal meaning of "ecosystem") for smaller systems, providing the conditions for their emergence and autonomous activity and then constraining them to grow or act in a way that contributes to the common good of all components, and thereby augment the life of the whole system (Johnson 35-60; Depew and Weber 407, Ulanowicz, *Third* 163). That is, organisms are systems of systems in synergetic relation to each other. This is most clearly the case with multi-celled organisms where the whole provides the home for the individual cells (or, perhaps more accurately, the environment in which cells can make their homes), fostering their emergence while, through control of their environments, coordinating their activities so that they contribute to the common good, thereby augmenting the life of all these cells. However, Lynn Margulis and Dorian Sagan have shown that eukaryotic cells, that is, cells with a sharply defined nucleus, consist of components that evolved independently of each other and then entered into symbiotic relation to each other in a way that produced new synergies (114). As Margulis put it, we are all symbionts. Mutualism precedes competition, and frequently competition is bounded by constraints that

reduce it to a mechanism in the service of systems united by mutualism (Ulanowicz, *Third* 118).

As with more integrated ecosystems, organisms are characterized by the form of complexity studied by Robert Rosen in which systems have multiple dynamics that are components of each other and produce their own components or provide the conditions for the emergence their components (Gare, "Approaches" 65ff.). Organisms also have a clearly defined semi-permeable boundary that differentiates an internal environment from an external environment with which they are in constant interaction, which is defined by the organism in relation to itself. As Jacob von Uexküll argued, the activities of living organisms are not simply the effects of their environment upon them since their environments are defined by them as their "surrounding worlds," those aspects of their environment that are interpreted to be of significance to them, to which they then respond, often creatively (126-77). Bio-semioticians such as Kalevi Kull have utilized Peirce's theory of semiotics to reinterpret the work of von Uexküll and traced the evolution of increasingly complex worlds from the cell and plants to animals and humans. Creativity is allowed for in Peircian semiotics with "abduction," which with the extension of semiotics to plants can be seen to have a place even with vegetative semiosis (Gare, "Semiotics" 6). However, a new dimension of creativity is opened up with the reflexive semiosis of humans. The evolution of organisms from prokaryote cells to humans can be characterized as levels of integration associated with new forms of constraint, facilitating more complex forms of semiosis (Gare "Process").

What then is "life"? Life can then best be understood as ecosystems, that is, as communities of dynamical processes in symbiotic relation, constraining themselves and able to constrain each other directly or through the mediation of signs, thereby coordinating their activities to contribute to their common good, reproducing and developing the environmental conditions for their reproduction and flourishing, and thereby maintaining themselves in existence as living communities. Ecosystems differ from machines in that their components are not mere instruments, but have autonomy and significance of their own. They contribute creatively to and modify the whole according to their own dynamics, and they differ from random arrangements of entities in that this creativity of components is nevertheless constrained, exogenously or endogenously, to augment the conditions of life for the members of

the community, thereby augmenting the life of the community. They are "eco-poietic," making homes (or niches) where their constituents can emerge, flourish, explore new possibilities and contribute to life through this home-making. All life consists of communities of communities that create, provide, and augment homes for themselves and their component communities, while augmenting the homes of each other and thereby the life of the communities of which they are part, providing the conditions for their flourishing, exploration, and creative advance into the future.

Ecosystems can be healthy or unhealthy (or, more broadly, can have or lack integrity).[5] "Health" is characterized by mutual augmenting of the whole community and the component communities of each other at multiple levels, facilitating their continued successful functioning, their resilience in response to new situations and stress, and for ongoing change and development to maximize developmental options (Ulanowicz "Toward" 99). Characteristically, health is associated with the generation of forms consisting of mutually augmenting centers at multiple scales. The breakdown of health can have many causes, but is characterized by loss of coordination, excessive differentiation and specialization undermining the possibility for communication, corruption or breakdown of semiosis, loss of balance between centers, resulting in destruction of the conditions for creative responses to new situations. These causes can be generated outside the ecosystem, but can also be endogenous, often involving semiotic debilities (Salthe, *Development* 265). Endogenous debilities are frequently associated with the breakdown of constraints on component communities as occurs for instance in cancer, where cell reproduction produces tumors which, if they do not destroy vital organs, absorb all nutrients and starve the rest of the organism. "Death" is the final breakdown of such coordination and thereby the destruction of the homes conducive to the flourishing of component systems. We should think of all ecological communities, ranging from single cells to multi-celled organisms to local ecosystems and the global ecosystem as being alive. This justifies Lovelock's claim that the global ecosystem, as a living being, under adverse circumstances could lose its capacity to coordinate its components for their common good and become unhealthy or even die.

From ecology to human ecology: humanity as a component of Gaia

While the traditional Darwinian mechanism of evolution as variation and selection in the struggle for survival is not entirely wrong, it misrepresents what is most important in variation and in survival. Variation includes creative responses by organisms to their situations, responses of organisms to each other, and through these, the emergence of new kinds of organisms based on new kinds and levels of cooperation (Corning 21ff.), while one of the most important determinants of survival is the effect of organisms on their environmental conditions or "homes." Survival in competitive struggles between variants is of less importance, and should be seen as for the most part a means by which ecosystems maintain healthy components and "try out" new components. Furthermore, providing the conditions, that is, secure homes for creativity and emergence, requires ecosystems to limit competition. In more integrated ecosystems such as organisms, this involves developing skins to protect their components and sub-components from too much competition (Reid 34). Orthodox Darwinians tend to be blind to all this. They are also blind to teleology and creativity. New kinds of organisms can be regarded as experiments by ecosystems. They emerge with their autonomous dynamics, and if they interpret and respond to their environments in a way that augments their ecosystems (which can be through limiting the excessive proliferation of other organisms, or augmenting the conditions of other organisms) they are preserved. On the other hand, ecosystems, and this includes the global ecosystem or Gaia, effectively remove those organisms that foul their own nests. Cancerous tumors are good examples of such organisms, which, failing to respond to environmental constraints and destroying the conditions of their existence, are either eliminated by the organism in which they emerge, or are eliminated through the elimination of the organism that was their home. Whole species of organisms can foul their own nests in this way, and be eliminated.

On this basis, humanity can be regarded as a very complex experiment by the global ecosystem or Gaia. It is complex because it involves a multiplicity of new kinds of organization, cooperation, and creativity, from local communities to global civilization. All this complexity is made possible by the unique kind of semiosis characteristic of humans whereby semiosis itself becomes an object to be interpreted. This second order

semiosis enables humans to constitute their worlds as shared worlds in which individuals see themselves as components of the worlds of others, making them more essentially cultural beings and thereby more creative than any other animal (Wheeler). The most obvious manifestation of this semiosis is human language that drives the quest to represent the world more adequately. However, while language is extremely important, there are two other dimensions or "dialectics" of culture which are irreducible to language and the dialectic of representation.[6] The second dialectic, the dialectic of labor, derives from the capacity of humans to identify functions and thereby identify forms and then produce forms to serve these functions, that is to identify "tools," shared instruments to augment control of the world, including weapons, machines, houses, roads, electronic media, and so on. This capacity has been shown by Umberto Eco to be a semiotic capacity (22). It is by virtue of this dimension that humans are major contributors to the morphogenesis of nature. The third dialectic, the dialectic of recognition, is the capacity of people to recognize and appreciate others as other subjects sharing with them a common world (Honneth 73ff.). This dialectic has been interpreted semiotically by George Herbert Mead. It is by virtue of this dialectic that humans form identities, develop a sense of justice and a sense of themselves as individuals with potential to be realized. As living systems, as Rosen characterized them, each of these dialectics of culture is a component of the others, yet irreducible to them. While most attention is paid to the dialectic of representation and the dialectic of labor, I want to focus here on the dialectic of recognition as this has been developed through the dialectic of representation.

As noted above, all emergent order involves new constraints, and this is also true of the dialectics of culture, including the dialectic of recognition. Proper recognition of others, the condition for establishing a proper sense of one's own self as a free agent, involves constraining of thought and action in taking into account the freedom and significance of others. It is this dialectic of recognition that is most important for creating complex institutions and forms of organization with stable role relationships that are sustained over generations. While partially autonomous, it is dependent upon and greatly augmented by a particularly important component of the dialectic of representation: stories or narratives. Stories also greatly augment the dialectic of labor by allowing people to develop complex forms of cooperation for projects over

long durations, extending beyond the lives of individuals. All complex actions involving many people are lived stories and require the telling and retelling the story of the action in which people are engaged. Stories are also central to the development of communities and institutions, and to maintaining their vitality. It is only through telling and retelling the history of communities and institutions that the point of their existence can be understood, questioned, and revised. And stories are central to individuals in their efforts to orient themselves in a socially constituted world, to live life authentically, and to refigure the stories they have inherited (Gare, "Primordial"). The development of history as the story of the past in the service of orienting people to create the future has engendered a drive for justice as the proper recognition of both oneself and others. While this might have begun with the quest to do justice to a small number of individuals, the "heroes" of society, the process of people orienting themselves through histories carried with it a tendency to extend such recognition. To begin with, this was associated with extending recognition to other members of a community, then to the community's institutions, then to other communities. As such the dialectic of recognition, augmented by narratives, has the potential for achieving a harmonious social order based on justice, which can be extended to the whole of humanity and then to the rest of nature. Especially with the development of the printing press, the telling of history carried within it an impetus to develop into a grand narrative encompassing all human communities, including all civilizations. The works of historians from Herder, Hegel, and Marx, to Joseph Needham, Fernand Braudel, and Immanuel Wallerstein, illustrate this. Finally, this has led to histories which situate humanity within nature, recognizing the significance of all life forms, exemplified by Ponting's *A Green History of the World,* and Guha, *Environmentalism: A Global History.* Along with these there are histories of the development of environmental thinking.

However, recognition of a kind can also be achieved by people defining themselves as a community against a diversity of others. Since the dialectic of representation and the dialectic of labor are components of the dialectic of recognition, these are constrained by the form the dialectic of recognition takes. Most agricultural civilizations engendered social forms characterized by groups unifying themselves into elite classes in opposition to other members of their society and to others of neighboring societies. While originally serving some function, such as defense or

the organizers of irrigation, their contribution to the communities from which they emerged was characterized by rapidly diminishing returns for the resources they expropriated. Exploiting subordinated classes and reducing them to mere instruments for producing prestige goods to define their superiority and for developing the military means to extend their empires and attack the ruling classes of other societies, they became parasites on the subordinated classes. What histories they told were histories of these elite classes, sometimes histories of only one individual, the king. Such elite classes have been forms of cancer within their ecosystems. Intensifying exploitation of peasants and through them the land and forests, they destroyed their ecosystems, leading to collapse of their civilizations and to "dark ages" (Chew, *Recurring* 82). This trajectory was followed by the Maya civilization, which began its collapse in the ninth century C.E. and has been intensively studied (Tainter 152-78), but it is also the trajectory followed by the bronze age civilizations (Mesopotamia, Harappa, Mycenae, Minoa, and Egypt) over three thousand years ago, various civilizations in the Americas, the Western Roman Empire, Islamic Mesopotamian civilization in the late ninth century C.E., and Byzantine civilization.

Industrial civilization has continued on the same trajectory, except on a far greater scale. Originating in Britain and then spreading first to Europe and then around the world, either associated with European colonization or in response to the threat of subjugation by industrialized societies, industrial civilization has been characterized by intensified exploitation of nature through the use of fossil fuels, imperialism, and warfare on a massive scale. It has been associated with elite classes committed to domination of members of their own societies, workers as well as peasants, and domination of other societies and their resources, and to the production of prestige goods and weapons on a scale unimaginable to the ruling classes of agricultural civilizations. The outcome is the modern world system, the functioning of which is well characterized by Stephen Bunker:

> The flow of energy from extractive to productive economies reduces the complexity and power of the first and increases complexity and power in the second. The actions and characteristics of modern states and their complex and costly bureaucracies accelerate these sequences. . . . Extractive appropriation impoverishes the environment on which local populations depend both for their own reproduction and for the extraction of commodities for export. . . . Once the profit-maximizing logic of extraction for trade across regional

> ecosystems is introduced . . . price differentials between extractive commodities and the differential return to extractive labor stimulate concentrated exploitation of a limited number of resources at rates which disrupt both the regeneration of these resources and the biotic chains of co-evolved species and associated geological and hydrological regimes. . . . The exchange relations which bind this system together depend on locally dominant groups to reorganize local modes of production and extraction in response to world demand, but the ultimate collapse will be global, not local. The continued impoverishment of peripheral regions finally damages the entire system. (21ff., 47, 253)

The result has been massive ecological degradation, which is accelerating with the globalization of the economy. Noting recent developments of the world economy, Ho and Ulanowicz pointed out:

> The economic globalization promoted by the rich countries in the World Trade Organization is aimed at removing all barriers to trade, finance and procurement, which is tantamount to destroying the system's intricate space-time structure. This inevitably results in the over-exploitation of the poor, especially in third world countries, that will impoverish the whole economic system. But that is not all. As the global economic system is embedded in the global ecosystem, over-exploitation in the global economy will drive people to use natural resources at unsustainable rates, so that the global ecosystem increasingly fails to renew itself. This leads to diminished input into the economic system so that even more natural resources will have to be harvested, resulting in a vicious cycle that will ultimately destroy both the global economy and the earth's ecosystem. (47)

The consequences for the elites have been avoided partly through the range and extent of countries they have been able to exploit, but also by the development of new technologies that have extended the possibilities of the exploitation of nature. This civilization, characterized by dissociation between cultural and ecological evolution, has been able to both advance itself while blinding itself to its destructive effects through the worldview of reductionist materialism (Norgaard 66ff.). Reductionist scientific materialism has provided the knowledge to develop most of the technology of industrial civilization, but it has also underpinned economic theory, Darwinism, and Social Darwinism, through which the reduction of nature and lower classes to mere instruments has been justified, and the destruction of ecosystems, societies, and civilizations legitimated as the inevitable byproduct of economic and evolutionary progress. This

worldview has largely neutralized the quest for justice, the very idea of which is incomprehensible from the perspective of reductionist materialism. Progress has been defined as the total reduction of nature and people to instruments for the maximization of profits and disposable income.

The impending global ecological catastrophe has undermined the legitimacy of all of this, and the global financial crisis of 2008 has further exposed the illusions cultivated by the elite classes that their massive accumulation of wealth and power and their massive levels of conspicuous consumption benefit "economic growth" and thereby humanity. For the global ecological catastrophe to have been recognized as a threat is testament to the advance of the dialectic of representation (associated with the development of history and science), and along with this, the dialectic of recognition (associated with institutions that have crystallized and extended recognition) in opposition to reductionist materialism. Through the advance of science beyond reductionist materialism, realigning the sciences with the humanities, the grand narratives of the whole of humanity not only have been revived, but extended. Humanity is beginning to understand that it has a potential function in nature, and that function is to appreciate the significance of life and to develop and use their intelligence to augment the life of humanity through augmenting the life of the global ecosystem, and that if it does not embrace this function, it faces extinction. Appreciating this is appreciating the contribution of human culture to the semiosphere; it is the advance of life's semiosis to the stage where, through humans, Gaia has become conscious of itself and its significance, and the problems confronting it, the most important of which is the current trajectory of human civilization (Gare "Semiotics"). At the same time this semiosis reveals the quest for justice, the proper recognition by component organisms of the dynamics and significance of ecosystems of which they are part, as integral to healthy ecosystems. The advance of the dialectic of recognition whereby people constrain themselves according to their growing appreciation of the significance of "others," both people and other organisms, or more generally, ecosystems, are the constraints required to return local ecosystems and the global ecosystem to health. The science that integrates all this, and thereby transcends the opposition between science and the humanities, and which can thereby give a place to the narratives and more abstract thought through which humans create themselves and redefine their relation to each other and to the rest of nature, is ecology.[7]

Redirecting humanity through ecology: the ethics and politics of eco-poiesis

With the perspective provided by ecology, including human ecology, we can now re-examine the proposals to deal with the threats to global ecological destruction. Vandana Shiva is certainly justified in calling for proper recognition of the local knowledge and forms of life of peasants who have developed sustainable forms of agriculture. In general, such wisdom, lost with industrial civilization, involved wasting nothing, recycling everything, and minimizing impacts on nature. However, agricultural civilizations have been characterized by oppressive ruling classes who oppressed their peasantry. It is also necessary to recognize the contribution that could be made to agriculture by ecological research, and more importantly, by philosophical ideas and the development of political, social and economic structures that could constrain the exploitative and destructive tendencies of humanity, inspire people to augment the life of their communities, and to recognize and empower those who aspire to live sustainably and to augment life. It was virtually inevitable that until a global civilization had formed that more brutal and more ecologically destructive societies would subjugate those societies that were based on greater justice, as occurred when the Qin dynasty triumphed over the other warring states in Ancient China. Now that a global civilization has formed, it is necessary to transcend the values and ideals of this brutal civilization. But this civilization has provided the cultural and technological means to transcend a social order based on the ruthless struggle to dominate.

While much of the technology of industrial civilization is incredibly destructive, some of it can be utilized to create a more harmonious society. Efficiency in the use of resources can be greatly improved, although there are limits to this. Jim Hansen's call for nuclear power looks suspicious. Nuclear power plants in the past have been large-scale affairs associated with the concentration of economic and political power while using up the very limited resources of U235. However, some of the proposed fourth-generation nuclear reactors could be small affairs, generating power for towns or villages for centuries with a molten salt thorium reactor or a reactor using U238 (with only a very small amount of U235) generating little or no waste or materials that could be easily used to manufacture nuclear weapons. However, such nuclear reactors are not yet fully operational. It will take ten years to overcome all the engineering problems to

make thorium reactors fully operational, while reactors capable of using U238 are still only on the drawing board and are at least thirty years from being operational (Wald). This is too long.

Lovelock's suggestions, even though characterized as "geo-engineering," are different because they assume a living world in which life processes can be constrained to improve the health of ecosystems. Of the proposals considered by Lovelock, the most promising is the burying of charcoal. To work properly this should be based on small-scale units, using relatively small-scale technology which should be easy to develop to turn agricultural waste such as rice or wheat stalks into charcoal, and then burying it. An important feature of this is that while it can double or even treble crop yields, charcoal does not function as a fertilizer. It builds up the eco-dynamics within the soil, generating soil ecosystems rich in micro-organisms which enable plants to utilize the nutrients in rain while preventing leaching and retaining moisture, thereby allowing crops to be grown with much less or no fertilizer and less water (Lehmann and Joseph). This is *terra preta* soil. This strategy is based on augmenting the ecosystems on which we depend and, ultimately, in which we are participants. This is only the beginning, however. Humanity will have to develop production processes in which everything can be and is recycled, to generate coupled cycles in which the output of one cycle is the input of another, as called for by McDonough and Braungart in *Cradle to Cradle*.

It is important to think about more than "technological" aspects of this, however. Ultimately, to create a civilization that is sustainable, it will be necessary to dramatically change the way society is organized and the way people live. To avoid the kind of destructive exploitation that has characterized past civilizations it will be necessary to create a global civilization that empowers people to augment their ecological communities and inspires them to do so, but also to limit themselves, for instance, by limiting the number of children they have and limiting their consumption. In place of a social order which concentrates power, wealth, and income, subjugates farmers and workers, reduces people to instruments, fosters greed and promotes consumerism, it is necessary to create a social order globally and locally in which people gain a sense of identity, adventure, fulfillment, and meaning in their lives through participation in their communities, working creatively in cooperation with others and participating in the life and governance of these communities. Social life should be constrained to free people to contribute to the

common good and thereby to augment life. Most importantly, it is necessary to free people from enslavement to the laws of the market by subordinating markets to communities, reducing markets to instruments serving these communities. To overcome the seductions of consumerism it will be necessary to uphold a superior ideal of civilized life. People need to constrain themselves by their commitment to truth and justice, their appreciation of beauty, and the need to harmonize these, and to be lured by the challenge posed by their communities' problems to adventure on new paths into the future.

The most promising path to achieve this transformation is the development of a hierarchy of communities characterized by organized decentralization, with a high level of civilization at all levels of society. Broader communities should provide the homes for more local communities, constraining the way they develop, preventing conflict and exploitation, enabling and inspiring them to develop their full potential to augment the life of their communities, while empowering these local communities to constrain the broader communities to ensure they work for the common good. The economy also should be organized in this way, protecting local economies from destructive competition. As Ho and Ulanowicz argued:

> We can deal with sustainable economic systems by embedding the global economic system in the global ecosystem. . . . The global economic system will have an intricate structure encompassing many national economies. Ideally, the intricate structure of the global economy should look like the many nested subcycles that make up the organisms' life cycle. . . . And each national economy, in turn, would have its own intricate structure that is self-similar to the global. If the entire global system is to be sustainable, there has to be a proper balance between the local and the global, the same kind of reciprocal, symmetrical coupled relationship that one finds in organisms. . . . Furthermore, the global economy is coupled to the global ecosystem, which too, has to have its own balance . . . so that both can survive. (43)

Communities can be constituted by a commitment to the common good of all members within territories of varying extent, from the local to the global (with the United Nations representing the global community), but also by commitment to specific causes, for instance the commitment of the community of philosophers, historians, scientists or artists to understanding the world and its significance, the commitment

of the community of journalists to revealing what is really happening in the world, or the commitment of the community of socialists to local and global justice. Local and national territorial communities should provide niches for people to participate in these more specialized communities, which will at the same time augment the life of these territorial communities. The Beijing Consensus, upholding the original ideals of the United Nations and defending the sovereignty of nations in opposition to the now discredited Washington Consensus, the effort to dissolve all communities into the global market, is an important development in this regard (Ramo). What also is required is the empowerment of local communities, and in particular rural communities that have traditionally been exploited by cities to the detriment of their ecosystems.

Ecology provides the forms of thinking required to constitute, maintain, and augment complexes of communities in this way. Ecologists have found that it is precisely such organized decentralization, with multiple processes mutually constitutive of each other, organized over many scales, with component processes provided with the niches to create themselves and develop their potential to contribute to the life of the communities of which they are part, which characterizes healthy ecosystems.[8] We need a world civilization structured as communities of communities at multiple scales, with human communities and their members recognizing themselves as components of and participants in these ecological communities, participating in the life of Gaia and, as Whitehead put it, in the "creative advance into novelty" (*PR* 28). A civilization must be in constant process of civilizing its members to understand both theoretically and practically the values inspiring this civilization. To achieve decentralization without this leading to corruption and conflict, an ecological civilization will have to develop and maintain a high level of education in all its members. Members, both individuals and communities, will need to embrace an ecological worldview to enable them to understand their place in the world, to appreciate the significance of life, to play their role in this complex of communities, to appreciate their unique situations and to see the significance and meaning of their own lives accordingly. Education in an ecological world-orientation is required to inspire people to face up to problems in the world and develop their full potential to augment their homes, including their own character, and thereby the communities of which they are a part. It is also required to provide the pre-eminent and overarching framework for democratic public policy formation in place

of policy formation by neo-classical economists (Gare "Human" and "Defending"). Creating such a civilization and concomitant world order is the challenge we face. If we fail, most of humanity will be destroyed along with its defects, and many of its achievements. This process will continue over thousands of years until humans get it right or are finally eliminated. It would be better to succeed on the first try.

Endnotes

*This paper is based on a paper given to a symposium in China on "Ecological Civilization, Globalization and Human Development" at Sanya, sponsored by Peking University, on 22 June 2009.

1. Lovelock first argued this in *Gaia: New Look*. After being challenged, Lovelock's theory was further defended and developed by himself, Lynn Margulis, and others, and precursors to the doctrine were traced in Lovelock's *Gaia: A Biography*; also see Bunyard, Midgley. For use of the thesis to diagnose the health of the global ecosystem, see Lovelock, *Gaia: Practical Science*.

2. Costanza and Daly co-founded the journal *Ecological Economics* in 1989.

3. At least in part. See Braudel 8.

4. See Needham, Goodwin, Pattee, Allen and Starr, Salthe, Ahl and Allen, and Juarrero. Hierarchy theory has been embraced by some theorists who nevertheless dislike using the term "hierarchy." See Dyke; also Gunderson and Holling.

5. This claim has been contested, particularly by Sagoff, but it has been defended, notably by Ulanowicz. On this debate, see Costanza; also Pimentel, Westra, and Noss.

6. On the semi-autonomy of the three dialectical patterns, see Habermas.

7. Major effort to formulate goals for humanity on the basis of ecology have been made by Howard and Elizabeth Odum; by Allen, Tainter and Hoekstra; etc. The perspective offered here, based on process philosophy and aligned with Bunker, Ulanowicz, Ho, and Salthe, differs from these by emphatically situating the development of ideas in relation to political struggles within, and as part of, nature.

8. See Reid; Goodwin (*Leopard*, ch.7); the papers in Pimentel, Westra, and Noss; Yorque; and papers in Waltner-Toews, Kay, and Lister. See also Allen, Tainter, and Hoekstra.

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