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Sustainable co-evolution

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SUMMARY

Humankind is dependent upon Earth's ecological life support system, whose well-being, in turn, depends upon the practices of human society. The health of both systems requires harmonious, mutualistic interactions between them. Because of its population size and demographic distribution (increasingly urbanized), humankind is also dependent upon its technological life support system, which, as currently managed, threatens the ecological life support system. A fundamental difference exists between the two systems—humankind is capable of using intelligence and reason to regulate its activities but the 30+ million other life forms that comprise the ecological life support system cannot. As a consequence, empathy for the other system is the responsibility of human society. Sustainable coevolution requires that human society have a high level of ecological literacy and act in a nurturing, compassionate way toward the other system. Only then will sustainable coevolution be possible since both systems are dynamic and continually changing.

The human race has only one or perhaps two generations to rescue itself … The longer that no remedial action is taken, the greater the degree of misery and biological impoverishment that mankind must be prepared to accept …
Paul Brown, *The Guardian Weekly*

BASIC DEFINITION

The basic definition of coevolution is "the simultaneous development of adaptations in two or more populations, species *or other categories* [italics mine] that interact so closely that each is a strong

selective force on the other" (Raven and Johnson, 1986). The concept of coevolution has been used most commonly to describe paired changes in species such as butterflies and the flowers they feed on (e.g. Ehrlich and Raven, 1964), hosts and parasites (e.g. Pimental *et al.*, 1978), and predator/prey relationships (e.g. Thompson, 1986). The term coevolution has been used to describe changes in more than species pairs, such as the reciprocal changes in agricultural practices and weeds (e.g. Ghersa *et al*., 1994). In cultural anthropology, the concept has been used to describe paired changes in human culture and human genetics (Durham, 1991). Janzen (1988) and Cairns (1994) have used the concept to describe the relationship between human society and natural systems. Cairns (1994) also points out that the relationship can be either mutualistic or hostile.

SELECTIVE FORCES

The key concept of the mutualistic coevolution definition is that interacting entities must serve as selective forces on each other so that the changes enhance the survival of each partner or system, i.e. Earth's ecological life support system and human society should interact so that changes enhance the survival of each component. Human society has been a strong selective force on the global environment (Myers, 1979; Wilson, 1988; Ehrlich and Ehrlich, 1991; National Research Council, 1992; Brown *et al*., 1992; Tilman and Lehman, 2001; Gardner *et al.*, 2003. Understanding the mechanisms of mutualistic coevolution should enhance the debate on global environmental issues.

Interaction between the ecological life support system and humankind takes various forms. For example, submergence of islands due to sea level rise is a major cause of habitat loss (e.g. Taylor, 2003). Brown (2001a) describes a variety of stresses that damage the biota and their habitat. In addition to physical destruction of habitat (e.g. deforestation) and more destructive storms (Stevens, 1997), chemical stressors such as pollution and climate change (e.g. greenhouse gases) are also present.

Of course, other species can act as selective forces on human society. Best known are the effects of disease organisms and agricultural pests or other interactions that affect industrial systems in a variety of ways (e.g. Cairns and Bidwell, 1996). At present, it might appear that natural systems do not exert a strong selective force on humankind nor are they capable of doing so. A pandemic disease would quickly alter this misapprehension, and numerous other scenarios are known to the environmentally literate. A technological society can do much ecological damage quickly, but natural systems often take decades or more to react; however, eventually they do. Nature can and will overcome the damage caused by humankind. Unless humankind develops a more harmonious lifestyle, the relationship of natural systems and humankind will not be a mutualistic one.

FUTURE EVOLUTIONARY TRENDS

For most people, a future Earth without humans is unthinkable, yet Dixon and Adams (2003) have explored this possibility using fundamental biological and evolutionary principles. They postulate both a human era and a post-human era. All species eventually become extinct; why should humans be an exception? The quest for sustainable use of the planet assumes that humankind will quickly learn enough about how Earth and its natural systems work to make continuity possible. Sustainability hypothesizes a harmonious, mutualistic relationship between humankind and the ecological life support system that is sustainable, i.e. capable of lasting indefinitely. Wilson (2002) believes that, in the end, success or failure (in humankind's relationship with nature) will depend on an ethical decision on which those now living will be defined and judged for all generations. Obviously, if I did not believe in the possibility of sustainable use of the planet, I would not, at 80 years of age, be spending time writing about it. However, excessive optimism is not justified since complex civilizations do collapse (e.g., Tainter, 1988)

Sustainability faces daunting issues. Myers and Norman (2001) state that the present biotic crisis will surely disrupt and deplete certain basic processes

of evolution, with consequences that will persist for millions of years. Ehrlich (2000) has discussed the magnitude of the crisis, but believes, as I do, that there is still time for remedial action that is within the capabilities of humankind. However, evolution is not predictable, so adaptability must be continuous, not just a matter of a few generations.

The quest for sustainable use of the planet is based on the assumption that human births can continue for an indefinite period in order for the species to survive. Death of individuals is distressing, especially in very large numbers; however, if there are enough normal births, *Homo* sapiens will persist. However, dinosaurs did not recover from environmental change, although life continued despite their loss and the loss of a number of other species. To achieve sustainability for *Homo sapiens*, it is essential to protect both natural systems and evolutionary processes. One important task is to end the ecological and genetic isolation of populations that have been fragmented by human activities. Nigh *et al.* (1992) recommend that humankind preserve the *processes* underlying a dynamic biodiversity at all levels. Tilman and Lehman (2001) assert that human-caused environmental changes are creating regional combinations of environmental conditions that, within the 21st century, may fall outside the envelope within which many of the terrestrial plants of a region evolved. Clearly, animals, including humans, will be affected by these changes should they occur.

MAKING THE CONNECTIONS

Havel (1990) notes: "Education is the ability to perceive the hidden connections between phenomena." The age of specialization has produced much useful knowledge, but the connections between components have been badly neglected. As Morowitz (1992) remarks: "Sustained life is a property of an ecological system rather than a single organism or species." No species, including humans, can exist in isolation from the ecological life support system. This crucial connection of humankind with the ecological life support system has not received the attention it deserves and is an essential component in achieving sustainability. Since the connection is between two dynamic systems, mutualistic coevolution is the only path to success. The transition to a sustainable future is partly a technical and scientific problem, but is primarily a matter of ecological and sustainability ethics (Cairns, in press).

A key concept is that humankind is a part, but only a part, of a complex network of species called the interdependent web of life or, from an anthropocentric point of view, the ecological life support system. Especially in this information age, humankind should be able to coevolve with the larger ecological life support system of which it is a part. In short, humankind must design practices that are compatible with the design of nature to reach the ultimate goal of sustainable use of the planet. A condition of reaching this goal is maintaining the integrity and health of ecosystems, so that these dynamic systems can function within normal variability and not be forced into disequilibrium. Natural laws cannot be ignored without severe penalties. A "partner" unable to coevolve with the other partner is in serious, probably fatal, trouble. At present, human society is diverging markedly from a sustainable relationship with natural systems by damaging their integrity, health, and component species. Since these systems collectively represent natural capital, which provides ecosystem services (e.g., Daily and Ellison, 2002), human society will suffer more and more as ecosystems collapse and the course of biological evolution is altered.

REDUCING POINTS OF INSTABILITY

Havel (1990) remarked that hope "is not the conviction that something will turn out well, but the certainty that something makes sense, regardless of how it turns out." A satisfactory outcome for the quest for sustainable use of the planet will require much hard work and major reduction of and quick elimination of unsustainable practices. If the entire human population consumed like the population of the United States, at least four *more* planet Earths would be required. If Earth's entire population did so at the rate of people in high income countries, 2.4 *more* Earths would be required (Mastny, 2003).

An equally sobering point is that, *at present*, the average human already uses resources at a rate higher than the planet's biological capacity to replace them (based on calculations on the biologically productive area needed to produce the resources used and absorb the waste generated by the human population [*Ecological Footprint Accounts: Moving Sustainability from Concept to Measurable Goal, Redefining Progress*, Oakland, California, 2002]). Mastny (2003) gives numerous alternatives to present practices, i.e. sustainable practices are available. Human society cannot negotiate with nature or ask for forgiveness for past environmental damage. Failure of the ecological life support system will be the ultimate consequence of ignoring natural law.

Each day, humankind makes choices both individually and collectively. Some examples related to sustainability follow.

1. Economic growth cannot continue indefinitely at the expense of natural capital and ecosystem services. Humankind is now choosing economic growth.

2. Humankind, especially in the United States, has chosen material consumption over ecological and sustainability ethics.

3. The wealthiest 20% of the world's population possesses 85% of all automobiles, consumes 84% of all paper, uses 65% of all electricity, and consumes 45% of all meat and fish (United Nations Inter-Regional Expert Group Meeting on Consumer Protection and Sustainable Consumption: New Guidelines for the Global Consumer, Sao Paulo, Brazil, 28-30 January, 1998). Humankind in the wealthy nations chooses to pay only minor attention to this disparity.

4. Wealthy consumers choose not to make major alterations in their buying practices to favor less wasteful and environmentally sound production of material goods.

5. Humankind chooses to ignore the adverse effects of biotic impoverishment, which consists of both extinction of species and a mega-mass extinction of populations.

6. Humankind chooses to worship technology to a degree that humankind believes it can manipulate a biological future.

7. Humankind chooses to minimize problems of carrying capacity. Hardin (1993) discusses the challenge of limits and the inescapable conclusion that per capita share of environmental riches must decrease as population increases.
8. Arguably, humankind's worst choice has been the failure to show empathy for its descendents and those of the 30+ million other life forms sharing the planet. Leaving a habitable planet instead of a damaged one is the essence of sustainability.

9. Humankind chooses to ignore unsustainable practices, while politics and many corporations hinder attempts for public debate. Since corporations control the news media either directly or through advertising, the debate is finding life on the internet. For example, how will the 2 billion people, who are projected to be added to the world's population between 2000 and 2030, mostly in poor nations, be able to lead a quality life?

ENVIRONMENTAL ECONOMICS

In order to promote the coevolution of human society with Earth's ecological life support system, the accurate environmental costs of humankind's practices must be expressly included in all economic analyses. At present, valid assessments are not the norm, although some fine examples of "green" economics exist. Instead, environmental costs have been relegated to the status of externalities; futures are discounted; natural capital is not depreciated; and the environmental costs of waste products are not assessed. Fortunately, there is an environmentally friendly means of preserving natural capital and the services it provides (Hawken *et al.*, 1999). However,

these attractive alternatives are diminished in effectiveness because the feedback loops, both economic and environmental, have markedly reduced effects due to government subsidies (Myers and Kent, 2001).

Even when economic and environmental feedback loops are not rendered less effective by subsidies, humans and the environment are still exposed to untested chemical substances for economic and political reasons. Scientific, social, economic, and political systems often unintentionally cooperate in this human experiment (e.g. Schettler *et al*., 1999). On the other hand, increasing evidence suggests that present economic systems are beginning to recognize the value of natural capital and ecosystem services.

The US National Academy of Engineering (1996) states that a primary challenge for the future is to maximize the benefits of technological innovation and use while minimizing undesirable environmental effects. However, Brown (2001b) states that the issue is not whether humankind knows what needs to be done or whether technologies are available, but whether social institutions are capable of bringing about the change in the time remaining. Earlier, Wells (1920) wrote in *The Outline of History*: "Human history becomes more and more a race between education and catastrophe." Lovelock (1988) added a cautionary note that humankind is in a new world that is harder to make sense of and riskier to speculate about—not just more to be learned but everything must be learned. Lovelock (1988) further states that emphasis should be shifted to a concern for the planet rather than a concern for humans. Living sustainably is the sine qua non for this shift. Sustainable use of the planet is essential to a mutualistic, harmonious relationship with natural systems of which humankind is a part.

CONCLUSIONS

Even discussing the collapse of complex civilizations is likely to generate criticism, as is the case for any imminent disaster, despite persuasive evidence that this has occurred throughout human history. Even more apocalyptic is discussing the possibility of a post-human world, even though there is abundant evidence that most species have a finite period on the ecological stage in the evolutionary theater. However, discussing these unpleasant outcomes is the best way to determine how to avoid them.

Developing sustainable coevolutionary policies is based on assumptions: (1) humankind is dependent upon Earth's ecological life support system, (2) the best way to avoid redirecting evolutionary processes in ways unfavorable to humankind is to develop a mutualistic relationship with natural systems, (3) since, at present, humankind is also dependent on its technological life support system, it should be managed so that it is not a threat to the ecological life support system, (4) despite overwhelming evidence that most species become extinct, *Homo sapiens* might be an exception if it uses reason coupled with a vastly improved level of environmental literacy. (5) although science and technology are essential to achieving sustainability, they must be guided by ecological and sustainability ethics.

Achieving sustainable use of the planet is the "acid test" of human intelligence, reasoning, adaptability, and wisdom. Humans must demonstrate that they are, as a species, fit to meet these enormous challenges.

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