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Systems ecology and environmentalism: Getting the science right. Part I: Facets for a more holistic *Nature Book* of ecology

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ABSTRACT

This is the first of two numbered papers for this Special Issue dealing with the ecological basis of environmentalism. The second follows, in a subsequent issue if not here. Patten (2013) gives a short preview of both papers.

Problems of environmentalism—environmental protection, conservation, and preservation—are now widely appreciated as important to human enterprise and destiny. Called to attention by advances in descriptive empirical ecology, the new problems are too complex for this same ecology to solve without further expansion of basic knowledge. To understand how nature works two kinds of science are needed, one empirical, describing what is immediate and tangible, the other theoretical, developing first-principles understanding of what is indirect and intangible. Development of a complex systems theory based ecology is hindered by over-commitment of attention and resources to applied environmentalism. This may in its inadequacy run counter to how nature works, which could be detrimental to both humanity and nature. It is important to get the science right.

As background for a revisionary hypothesis presented in Part II, five elements of basic ecology and five of applied environmentalism are here reviewed. The basic topics are ecological energetics, linear vs. nonlinear dynamics, steady vs. non-steady states, epistemic mediation, and indirect effects. The environmental topics are overpopulation, biodiversity, invasive species, sustainability, and global change.

1. Introduction

The world is nonlinear (20.2 million). There are no steady states (78.0 million). Chaos and catastrophe loom (11.6 million). Populations are isolated (26.8 million). Communities are individualistic (1.31 million). Ecosystems do not exist (4.59 million). Searching for first principles is physics envy (0.67 million). There are no ecological laws (28.0 million).

These are some of the absurdities written into today's ecological *Book of Nature*. Their anchoring in culture is indicated by the number of url's (in parentheses) returned when they are googled. They do not represent the ecology I know; every one of them opposes my own understanding. The statements raise questions, the stuff of problem solving. And they are the offerings of problem solvers—the scientists who work, have always worked, under the patronage of problem solving societies. No problems, no work, no patronage. Not rocket science, as they say, that the prevailing worldview should have an unsettled, in-need-of-attention cast. But it's only correlation, not causation, as they also say. Withal, agenda science happens, and serves valid social purposes. But does it also serve basic-science purposes—to understand and explain, and predict if possible, how nature works?

Environmentalism is ecology's agenda science. Applied science is a version of this but usually has a subset relationship to broader interests. Ecotoxicology is applied science, but environmental protection under which it falls is agenda science. In the environmentalist realm the world is always troubled, poisoned, unsettled, teetering on collapse, and rarely benign or nurturing or stable as most organisms experience it, and as most watchers of organisms in the wild observe them experiencing it. To those who look outdoors, the biosphere appears to be a good and agreeable place to live for those that fit it, and those many more that do not are the dying evidence of ample exclusionary mechanisms in place to enforce the rule of natural selection. None of that is rocket science either.

This paper, and its Part II sequel, advocates ecology's return to inquiry science, neither agenda nor application driven, because there is still a mountain of basic science in need of knowing, especially about core holism, before an effective environmentalism can follow.

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1.1. EcoSummit-IV

I came to write these two papers (and a third, their digest; Patten, 2013) through my attendance at Symposium 63, *Restoration ecology in a sustainable world*, held at the 4th International EcoSummit meeting, September 30–October 5, 2012, in Columbus, OH, USA. This was followed by lively email exchanges among several of the participants, to which I contributed. I was asked during a panel and audience discussion on energy conservation in the final session to give some of my views. As a systems ecologist, I see the descriptive empirical science general ecology has to offer may have been very good for identifying problems but not for solving them. For that, a new and different complex systems science that goes beyond description is going to be needed, but environmentalism has achieved hegemony in scientific pursuits and this impedes such development. Rejection of holism for anything beyond principle is a much wider, and to me deeply puzzling, phenomenon. Especially in a science where many do see the need for complex systems directions but seem to be stuck—by training, history, and need to follow the fashions and rewards—in perpetuated old paradigm ways that are a poor fit to the new problems. While applied problems can and do motivate pure science, the social press of dominant orthodoxy inhibits this by directing attention and resources to largely pragmatic ends.

1.2. Environmentalism

The EcoSummit, of course, was devoted to the lead environmental topics of the day—and why not? Continuing our own species by properly integrating it into the planetary flow is not an unworthy goal (every life form has it, on some level). All (or most) humans want a stable nurturing planet, ample energy and material resources, pure air and water, freedom from disease and toxic substances, safe and clean environments, pleasant and reliable surroundings, self-perpetuating ecosystems of balance and beauty supporting a rich and diverse array of living species. Environmentalist goals are lofty and worthy of the best in humanity, and it is right that society should turn to scientific ecology for guidance. But, it has to be asked, are the goals consistent with hard scientific realities, does scientific ecology understand the latter well enough, and will contemporary applied directions be found correct if knowledge shifts under closer study? There is evidence, as I'll develop, particularly in Part II, that in some ways environmentalism may not run with the flow of nature as science understands this, but against it. Conserving natural resources, and preserving natural capital and values, are not what other species do or have done in the past—at least not to our eye. Entraining technological civilization, young in evolutionary time compared to natural laws established even before life began, is difficult terrain with elements in holism and complexity that traditional ecology has not much addressed before.

I know these things as an environmentalist myself, and as an ecologist who has spent a career investigating a deceptively simple life's question that turned out to be subtly hard—*What is environment?* I feel qualified to assert there is much more to know about "environment" and the organism–environment relationship before a fully competent, ecologically based environmentalism can ever be launched to meet the challenges of egregiously entangled complexity on the man-in-nature interface.

1.3. Darwin and holism

Darwin's (1859) "entangled bank" is not mythology; it is real and the epic work's original holism, suppressed by overpowering interests in apes and evolution, was never more poignant or relevant than in the present age. Systemic Darwinism, more than evolution, is reprised in the work's final passages:

> During early periods of the earth's history, when the forms of life were probably fewer and simpler, the rate of change was probably slower; and at the first dawn of life, when very few forms of the simplest structure existed, the rate of change may have been slow in an extreme degree. The whole history of the world, as at present known, although of a length quite incomprehensible by us, will hereafter be recognized as a mere fragment of time, compared with the ages which have elapsed since the first creature, the progenitor of innumerable extinct and living descendants, was created. . . .
>
> It is interesting to contemplate an entangled bank, clothed with many plants of many kinds, with birds singing on the bushes, with various insects flitting about, and with worms crawling through the damp earth, and to reflect that these elaborately constructed forms, *so different from each other, and dependent on each other in so complex a manner, have all been produced by laws acting around us.*
>
> These laws, taken in the largest sense, being *Growth with Reproduction*; *Inheritance* which is almost implied by reproduction; *Variability from the indirect and direct action of the external conditions of life*, and from use and disuse; a *Ratio* [sic: Rate?] *of Increase* so high as to lead to a *Struggle for Life*, and as a consequence to *Natural Selection*, entailing *Divergence of Character and the Extinction of less-improved forms.*
>
> Thus, from the *war of nature, from famine and death*, the most exalted object which we are capable of conceiving, namely, the production of the higher animals, directly follows.
>
> There is grandeur in this view of life, with its several powers, having been originally breathed into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms most beautiful and most wonderful have been, *and are being*, evolved.
>
> http://sciphilos.info/docs_pages/docs_Darwin_bank_css.html (italics added)

Global "goods" from local "bads" is the clear conception in this master naturalist's own words, and this will become the center of attention in the second paper of this pair.

1.4. Terminology

The word "global" reminds me to clarify some terms as I'll use them, less here, more in Part II. I will employ reductionism and atomism as equivalent opposites to holism, and also use a set of antonyms to reflect a core distinction inherent in concepts of network "distance" and related "realness" of entities. For *distance*: direct/indirect, adjacent/nonadjacent, proximate/ultimate, immediate/- remote (or dispersed, distributed), near/far, local/global (or nonlocal); for *realness*: real/ideal, ontic/epistemic, physical/virtual, material/- immaterial, concrete/abstract, tangible/intangible, palpable/impalpable, and visible/invisible. All the {left}/{right} members of these pairs will be taken as more or less synonymous in the network framework I will be working from, so I will mix and match them freely, for example: adjacent/indirect, immediate/ultimate, real/virtual, etc. The word global will have a network or planetary meaning, depending on context. The science I'll discuss also is dual: empirical vs. theoretical. In general, empirical aligns with left members of the above terminology pairs, and the second to the right members. Referring to Fig. 1 briefly (details later) for clarification of network directness vs. indirectness, all the adjacent node pairs connected by solid arrows are *directly* related, and (in context) all leftmost terms of the above-listed pairs can apply; similarly, all nonadjacent node pairs