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Systems ecology and environmentalism: Getting the science right. Part II: The *Janus Enigma Hypothesis*

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ABSTRACT

Aspects of ecology-based environmentalism may run counter to how nature works; it is important to get the science right.

The *Janus Enigma Hypothesis* is formulated as a flow–storage network approach to holistic ecological understanding. It proceeds from primary energy–matter consumption toward maximization of throughflow. When transferred material is energy, the goal function is maximum power (energy flow).

The Janus Hypothesis has the following line of development:

1. The *2nd Law of Thermodynamics* requires that the environments of aggrading (anti-entropic) processes become themselves degraded. To restrict such degradation is to limit life's processes.
2. A *maximum power* conjecture holds that aggrading systems self-organize to maximize power generating work. Maximal resource use, work production, and environmental degradation necessarily follow. This applies also to material flow in generalized energy–matter (throughflow) processing.
3. In maximizing power (throughflow), biota perform work to maximize their fitness (Type I, biological), but at the expense of degraded environments. Zero-sumness of conservative, consumptive transfers produces a proximate life–environment relationship that is win–lose.
4. But covert mechanisms also operate such that maximizing throughflow also maximizes a system-wide, nonzero-sum, network property—*dominant indirect effects*.
5. These maximize another property of network organization, *network synergism*. This transforms proximate, tangible, zero-sum, agonistic, (+, −) *transactions* into ultimate, intangible, nonzero-sum, mainly positive (+, +) and synergistic *relations*. The proximate transactions lead by network processes to ultimate nonzero-sum benefits > costs, which is network synergism.
6. By the *indirect* line from maximum power (throughflow) to network synergism, biotic work maximizes both biological and ecological fitness (Type II), and the life–environment relationship becomes win–win. This cannot be seen from pure empiricism because it plays out diffusely as limit processes in networks that are virtual.

Three lines of evidence are presented in support of the Janus Hypothesis: (1) "Building a biosphere" by progressively adding nodes and links in simple compartment models shows throughflow and network synergism to be positively correlated. (2) Decomposing the utility measure of network synergism in these models into its constituents shows them to be largely made up of throughflows; maximum network synergism likely follows from the maximization of throughflow. (3) Comparing total system throughflow with network synergism in 31 food webs described for Ukrainian pasturelands shows the two measures to be positively correlated in this large empirical database.

The Janus Hypothesis has a built-in paradox. Because the positive benefits derived from the nonzero-sum maximum throughflow → network synergism → Fitness-II line exceed the negative costs generated by the zero-sum maximum throughflow → Fitness-I line, applied programs designed to reduce environmental degradation will reduce not only Fitness-I, but also Fitness-II by foregoing the implicit benefits of network synergism that inherently exceed the explicit costs of maximizing throughflow. This is the *Janus Enigma.* It means that well-meaning but misguided environmental programs may actually, in fact must, induce a lose–lose relationship between life and environment. If the Janus Hypothesis proves scientifically valid, environmentalism must resolve and manage the apparent conflict, and ecology as its parent

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science must expand its dimensions and become a complex systems science competent in understanding and methodology to meet the challenges of complex, intractable, non-obvious holism in nature's living networks.

1. Introduction

Is eating and being eaten the only way to organize a biosphere? Why does humanity persistently practice war and strife while professing mythic peace? Is bad a needed crucible for greater good, and is this somehow mandated in physical and biological law?

Hard questions. Ecology cannot answer them. This paper continues to develop the Part I proposition that scientific ecology is not yet good enough to deal with similarly hard questions in environmentalism—the social movement it has helped spawn. Ecology's transition away from 18th/19th Century holism where it started was noted already a quarter century ago (Goldsmith, 1988). This drift has poorly equipped it for dealing with whole systems problems up to planetary scale (e.g., Gaian—Lovelock, 1979) that rose to 20th/21st Century prominence in human concerns. Atomistic ecology describes well predation, competition, carrying capacity and other forms of life limitation locally expressed, but it cannot relate these much to possible broader benefits and life enhancements that may derive from extended, nonlocal levels of organization—going beyond the immediate and visible struggle for existence to invisibly fashion a more agreeable abode for life on earth beyond hostility and conflict.

This paper proposes a dualistic approach to the scale-scaling problem of stretching ecological reductionism to fit environmental holism. Two duals will be involved. First, *conceptual*—looking downward and inward in the ecological hierarchy toward negatively cast mechanisms ("eating and being eaten", "struggle for existence") and direct causes, then upward and outward toward positive and dominant ultimate consequences (fitness, both biological and ecological). Second, *methodological*—in ecological network analysis, looking forward then backward through time and network organization to generate ultimate "goods" from proximate "bads." These two dualisms prompt the name "Janus" to call them constantly to attention.

Here are some premises that serve as background for Janus: (1) historical thrusts into holism by classical ecologists like Forbes (1887), Warming (1895), Cowles (1898), Clements (1916, 1936), Lindeman (1942), Vernadsky (1926, 1945), Odum (1969, 1983), Lovelock (1979), and many others have largely been abandoned in this era of ecology because empirical science, strongly favored to the virtual exclusion of theory (Peters, 1991), is ill suited to follow. (2) De facto retreat into simplicity leaves today's ecology largely a science of the immediate; its ultimate side is conceptually there, well enough given from history, but appropriate systems methodology to implement it is still to be built. (3) The latter must, as nature is intricately woven within and across organizational scales, include some form of network systems science. And (4), until a meaningful holism emerges, ecology will have only a tenuous hold on informing and empowering environmentalism.

The Janus metaphor fits not because of my January birthday, or that Lovelock's (1979) Gaia needs a male companion, but rather because as a compelling conception of life on earth the Gaia metaphor can benefit from a second look beneath the skirts of normal science for extra-empirical mysteries that may be lurking there beyond empirical reach. The Janus hypothesis challenges a widely held view (e.g., Peters, 1991) the goddess' empirical petticoats demurely hide—that reductive, descriptive science (the ecology of yesterday and today) can by itself provide all the knowledge that will ever be needed to understand how nature works and how mankind fits into its overall pattern of organization. The singular message here will be that first-principles theory is absolutely required to inform the data and perspectives that empirical observation and measurement provide. Janus' two faces, as they will become fashioned, look hierarchically downward–inward toward micro-origins and consequences, and upward–outward toward macro-origins and consequences, as well as temporally backward toward beginnings and forward toward endings. The environmental system theory behind the Janus perspectives has these up/down, past/future properties also.

The Janus rationale is as follows. Traditional ecology has raised important environmental issues and sees them through the lens of the empirical science it is. A holistic lens is taking form, however, on the knowledge horizon and is seeking to go beyond description and provide first-principles based theory to complement the empirical enterprise. Theory reaches into realms where empiricism cannot, and as in all mature sciences a full two-sided "Janus-look" will be required to understand how nature works, and also provide a sound basis for applications. The science behind contemporary environmentalism is one-sided, and the applied problems to which it has given rise are significantly ahead of ecology's sure knowledge and analytical capabilities.

2. The *Janus Enigma Hypothesis*

Five elements frame the *Janus Enigma Hypothesis*, and form the core of this "getting the science right" critique of environmentalism. The hypothesis will be abbreviated "JH/e" (e for enigma). It is offered not to denigrate or undermine environmentalism, but rather the opposite—to say to ecologists let us return to the pursuit of fundamentals in this still young science of ours, and make sure we get things right before offering limited or erroneous knowledge to the world. The JH/e is summarized in Sections 2.1 and 2.2.

2.1. JH/e: Overview

2.1.1. First look

Traditional ecology, confined to descriptive empiricism, cannot know all there is to know about how nature's ecological systems work. It can only know what it can see, feel, and measure directly—physical, discrete, concrete, and tangible energy–matter objects and their proximate causes and effects registered in stocks and flows generated by mechanisms of processes. By this, the empirical look portrays the life–environment relationship as win–lose. Life exploits environments to grow and gain fitness, and in the process degrades them. This is conventional biological fitness, subsequently referred to as "Type I", or *Fitness-I*.

2.1.2. Second look

The biosphere is replete with indirect causes and effects expressed within and across the scales of organization via networks of energy, matter, and information transfer. The interconnected components are concrete intersections of virtual flows—the conception from *Environ Theory* (Fath and Patten, 1999; Matis and Patten, 1981; Patten, 1981, 1982, 1987, 1993, 2007, 2016; Schramski et al., 2011) introduced by Patten (1978). But the