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What ecosystems really are—Physicochemical or biological entities?

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ABSTRACT

Classical systems ecology in the style of Howard Odum wasn't genuinely holistic. Odum reduced ecological phenomena to storages, fluxes and transformations of energy and by doing so he undermined the autonomy of ecological science. To surmount this situation, Patten and coworkers offer an alternative framework, namely environ analysis. Resulting in novel ontological perspectives, environ analysis attempts to represent phenomena that are characteristically biological in nature, rather than purely physical or chemical. However, Patten and coworkers do not assign autonomy to ecosystem processes related to these phenomena and lead themselves to the "reductionist trap". In an effort to escape this trap they throw off the traditional ecosystem models and proceed to methodological reforms. This way, they finally achieve to partly outmatch the reductionism associated traditionally with Systems Ecology, although the holding to a framework which overrates prediction probably jeopardizes the whole enterprise.

1. Introduction

It is generally accepted that traditional Systems Ecology did not respond successfully to the holistic request. For instance, despite passionate holistic declarations, Howard Odum, an originator of Systems Ecology, inclined to 'hypereductionist' approaches (Bergandi, 1995, 2000). This author produced the image of an ecosystem consisting of accumulated, released and interacting photons along with different forms of energy, finally transformed to heat (Mansson and McGlade, 1993). This way Odum discusses ecological phenomena exclusively in terms of thermodynamics. Accordingly, by subsuming analysis to physicochemical perspectives, Odum undermined the autonomy of Systems Ecology.

Considering that reinforcement of holistic issues will result in reinforced autonomy of Systems Ecology, many ecologists attempted to modify the theoretical core of the old ecosystem paradigm. In this context different research programs focusing upon specific topics were independently initiated by scientists such as Levine, Ulanowicz, Herendeen, etc., For instance, employing optimization methods, Nielsen and Ulanowicz (2000) studied topics associated with thermodynamic efficiency. By contrast, Patten, Jorgensen and Straškraba in a series of papers published during 1992–2000 in 'Ecological Modelling', under the generic title 'Ecosystems Emerging' undertook the difficult task to reform the entire theoretical core of Systems Ecology. These authors confined their efforts exclusively within the theoretical core, ignoring the fact that different elements of the scientific edifice such as models, vocabularies, experimental designs, techniques for analysis of the empirical data, etc., have coevolved to work in concert with the theoretical perspectives. Meanwhile, however, Patten, in cooperation with his co-workers J. Finn, M. Higashi, T. Burns, S. Whipple, B. Fath and others, showed enhanced concern for methothological issues such as network analysis. Network analysis is a general methodological framework allowing for the study of entities as parts of a connected system. It entails tools such as graphs and matrix algebra and aims at

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identifying all those organizational patterns that underlie system behavior (Patten, 1978, 1982, 1990; Fath and Patten, 1998, 1999a,b; Fath et al., 2001; Fath, 2004).

Specifically, Patten and co-workers deployed their own research program drawing upon General Systems Theory. Discussion of aspects relating to this endeavor is the object of this paper. In particular, we intend to discuss how these authors attempted to integrate environmental issues into ecological modelling in an aim to achieve their principal goals i.e. to overcome ecological reductionism seeking for interpretations exclusively at the physicochemical level (Fath and Patten, 1999a,b). We will show that in this regard they initiated a new theoretical approach termed 'environ' analysis to denote the analysis of the entire system of interrelations associated with each natural entity (Patten, 1978, 1982). More precisely, we will show that these theoretical innovations resulted (a) in novel ontological perspectives and (b) in methodological reforms.

1.1. *Reductionism versus holism*

The objective of this paper concerns the reductionism versus holism issue. This issue often slips into obscurity and thereby a short clarification of some key terms may be proved useful. Ontological reductionism maintains that the most fundamental physical level, whatever that turns out to be, is ultimately the real "ontology" of the world. Accordingly, anything else that is to keep the status of real must somehow be able to be 'mapped onto' or 'built out of' those elements of the fundamental ontology (Silberstein, 2002). In this context ecosystem is conceived as nothing more than a physical structure consisted of aggregates of physical particles (physical component parts) and matter–energy interchanges (physical relations). Apparently, this reductionist version of ecosystem takes no notice of the property of life and therefore disregards issues concerning the emergence of the biological level out of the physical one.

As a counterpart, ontological holism (or emergentism) rejects the idea that there is any fundamental level of ontology. Instead, it holds that there is a pluralistic ontology further specified to emergent (the biological arising from the physical, the psychical from the biological and the social from the psychical; Emmecke et al., 1997) and by some means independent domains.

Analogous remarks could be made for epistemological and methodological reductionism and holism provided that we focus on epistemological (epistemology refers to our theories or descriptions) and methodological issues. We will not further elaborate these topics. The only thing we would like to emphasize is that holists are also called autonomists because they defend biology's autonomy with respect to physics and chemistry. More specifically they claim that it is impossible to reduce scientific elements (elements that form a coevolved unity such as concepts, theoretical schemata, theories, etc.) about biological wholes (about phenomena qualitatively distinct from the physical ones) to analogous elements about their physico-chemical parts (Looijen, 1998). The holistic request, for example, presupposes that the formulation of physical causal relations or mechanisms is not sufficient to predict or explain the behavior of organisms. In the case of ecosystem ecology, it also presupposes that organisms' behavior is one way or another influenced by the function of the ecosystem (this latter considered as a whole appearing emergent properties) but this aspect of autonomy although important will not be thoroughly scrutinized in this article. Despite the attention we will pay on organizational aspects of the ecosystem, our primary concern is to show that if ecosystem ecology is going to take its place in the interior of science as an autonomous biological discipline, it should foremost avoid disconnecting ecology from biology.

1.2. *Overcoming reductionism*

1.2.1. *The ontological innovations*

Patten predicates that irrespective of Odum's beliefs, organizational rather than energy issues were of primary importance in his scientific edifice. In contrast, he considers energetics as a secondary element of the 'Odumian' construct (Patten, 1993: 598). He states, literally, that the energy metaphor of Odum is part of his scientific edifice only for two extraneous reasons. Firstly, because "*... he sought to anchor his theory in what he saw as basic reductionistic science ...*" and secondly, because "*... he had to have something concrete to measure since he is an empirical ecologist ...*". Consequently, in an attempt to defend the holistic declarations of Odum, Patten put particular emphasis on organizational aspects. However, within the Network Ecological Theory framework, holistic issues are differently treated. Firstly, Patten conceived 'environ' as an input-state-output object (Fig. 1; Patten, 1978, 1982). Secondly, he argues that apart from simple matter–energy exchanges (transactions), relations have also a significant organizational role (Patten et al., 1997). Thereupon, Patten et al. (1997: 248) mention that although relations stem from conservative transactions, they, nevertheless, can also serve as causes. Moreover, the authors stress the seminal possibilities of relational couplings.

According to Krivtsov (2004), mentioning relations the adherents of the Network Ecological Theory mean predation, mutualism, competition, commensalism and the like. This way, they attempt to describe the within ecosystem interactions qualitatively. It is worth pointing out that for Patten the significance of relations relates to communicative processes such as information exchanges and semiotic phenomena. These latter are supposed to emphasise semantic aspects of information such as the transmission and interpretation of signals (Patten et al., 1997: 248).

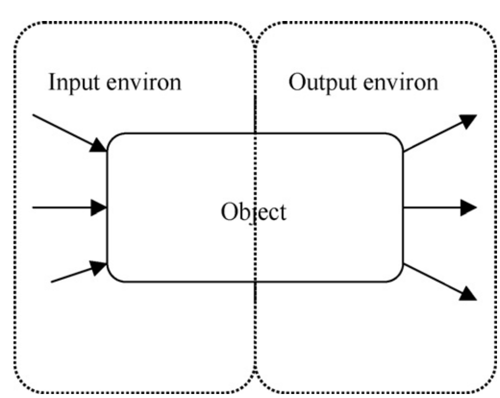

Fig. 1 – Pictorial representation of 'environs' conceived as an input-state-output object.