"Summary of article by Herman Daly: On Economics as a Life Science" in Frontier Issues in Economic Thought, Volume 1: A Survey of Ecological Economics. Island Press: Washington DC, 1995. pp. 138-140

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This article brings out the analogies between economics and biology. The similarity between economics and biology stems from the fact that the life process is the ultimate subject matter of both disciplines. The views of the total life process presented here derive from the steady-state and evolutionary aspects of the two processes. The paper will then consider the human economy from an ecological perspective.

The Steady-State Analogy

The within-skin (biologic) life processes of metabolism can be compared to the outside-skin (economic) life processes of production and consumption. The metabolic process consists of anabolism and catabolism. Anabolism, the process by which useful matter and energy is converted into living tissues, is similar to production in the economic system. Catabolism, which converts living tissue into degraded matter and energy, is similar to consumption in the economic process. The primary purpose of the metabolic process is the maintenance of life, while that of the economic process is the maintenance and enjoyment of life. In both processes, the only material output produced is waste. Edwin Schrodinger[1] (1945) described life as a system in steady-state thermodynamic disequilibrium, in which high-entropy outputs are exchanged for low-entropy inputs. A corollary to this is that no organism can live in a medium of its own waste products. Schrodinger's description and its corollary are a perfect physical description of the economic process as well.

The economic and metabolic processes fit together because metabolism is part of the economic subprocess of consumption. Many economic products are inputs into the metabolic process, and some outputs of the metabolic process, such as manure fertilizer and carbon dioxide, can be consumed in the economic process. The physical basis of the metabolic and economic processes undergoes continuous replacement in short periods of time. This replacement constitutes the steady-state aspect of both processes. Capital is essentially matter that is capable of trapping energy and using it for human purposes. Biological organs are endosomatic capital, and the environment, in the form of air, soil and water, constitutes physical exosomatic capital.

The Evolutionary Analogy

Replacement of the physical basis of metabolic and economic processes is equivalent to short term depreciation and investment. The physical basis also undergoes qualitative and organizational change over long periods of time. These long term changes are the equivalent of

technological change, and represent the evolutionary processes in metabolism and the economy. When the rate of anabolism is greater than the rate of catabolism, growth occurs, and then merges into development by giving rise to qualitative changes as well. In biological evolution genes transmit knowledge, while gene mutations modify knowledge to adapt to the environment. In economic evolution economic surplus propels growth, while culture transmits knowledge and generates new ideas that assist adaptation and development. While economic surplus leads to secondary economic activity that is far away from direct contact with nature, the biophysical foundations of economics are always present in the background.

The Human Economy in Ecological Perspective

Ecologists abstract from the human economy and study only natural interdependencies, while economists abstract from nature and study only interdependencies between commodities and man. As the biologist Marston Bates has suggested, ecologists pretend that man does not exist, and economists pretend that nature does not exist. However, the human economy is having serious effects on the ecology. Rather than dismissing these effects as externalities, the study of economic commodities should be integrated into study of the larger economy of nature.

A useful framework for understanding the interactions between the economy and ecology is the Leontief input-output framework. In its simplest representation, the total economy can be divided into human and nonhuman sectors as shown below.

From	*To*	
	Human	Nonhuman
Human	(2)	(1)
Nonhuman	(3)	(4)

Cell (2) represents the domain of traditional economics. All items exchanged here are economic commodities with positive prices. Cell (4) is the domain of traditional ecology, while cells (1) and (3) represent flows from the economy into the ecology and vice versa. Cells (1), (3) and (4) may be called ecological commodities that capture the biophysical foundations of economics; free goods (zero price) and economic "bads" (negative price) are included in these cells. The nonhuman sectors include animals, plants, bacteria, the atmosphere, the hydrosphere, the lithosphere and the sun. The standard Leontief input-output matrix is restricted to the activities in cell (2). This extension into the nonhuman sectors captures the entry of low-entropy energy and matter into the economic system and the outflow of high-entropy waste into the ecological system. In principle, the suggested extension should pose no problems, but practical problems do exist. The inputs and outputs in cells (1), (3) and (4) have not been measured, and doing so will require the cooperation of many disciplines.

Notes

1. Erwin Schrodinger, *What is Life?* (New York: Macmillan, 1945).