Search for Time's Arrow

The Entropy Law and the Economic Process. NICHOLAS GEORGESCU-ROEGEN. Harvard University Press, Cambridge, Mass., 1971. xviii, 458 pp. $16.

This is a blockbuster of a book. It should be reviewed by at least three people—an economist, a thermodynamicist, and a philosopher of science. As a mere economist, even with some amateur interests in the other two fields, I have to confess that there are considerable parts of the book which I cannot appraise. The first eight chapters are essentially philosophy of science, revolving around the contrasts among (i) the reversible, quantitative, "arithmomorphic" science of Newton and Laplace, (ii) the irreversible, qualitative science of classical thermodynamics and, one might add, classical evolution, and (iii) the stochastic thermodynamics of Boltzmann, to which I suppose might be tagged on quantum mechanics and other probabilistic modern sciences. In the middle of all this there is some quite technical criticism of the foundations of modern mathematics, probability theory, information theory, and Boltzmann's thermodynamics, with a brisk attack on the naive prophecies of the molecular biologists thrown in for good measure. This weighty diet, moreover, is spiced with a large number of fascinating asides, illustrations, aphorisms, and historical tidbits.

One despairs of giving any picture in a review of the richness and intellectual meatiness of the work. In all this richness, it is also hard to separate out what is essential from what is merely interesting, simply because almost everything is interesting. My mind indeed has been so stretched by this work that I find it a little hard to put it together again. There are not many concessions to the reader, who is supposed to know what Pascal means when he says "reasoning is not made of *barbara* and *baralipton*" (p. 80), must not be fazed by *ylem* (p. 124), must be prepared to worry about the probability of today's being Sunday (p. 162), and should be familiar with Diderot's *Dream of d'Alembert* (p. 349). However, the reader who can overcome these blows to his self-image as an educated man will find the style clear and the argument frequently very persuasive. There should be one stylistic warning. The use of the word "dialectic" does not seem to conform to the use on which I was brought up, and may confuse the reader. Georgescu-Roegen uses it to mean continuous, qualitative, not sharply differentiated, and nondichotomized. This seems to me a very important and useful concept, and I share with Georgescu-Roegen the view that reality is pretty much a continuous mess of moderately undifferentiated fudge and that most distinctions are man-made. But still it is not what my "humpty dumpties" meant by "dialectical" and I would hate to have the reader confused by this.

If one were to try to find a unifying theme in this rich intellectual tapestry, I think it would be the search for time's arrow. Newtonian mechanics (locomotion) has no arrow. The orrery can be turned either way, and it makes no difference to the equations. There is no widdershins in the heavens. Classical thermodynamics finds time's arrow in decay and the great decline toward universal equality of state. Boltzmann's attempt to reconcile mechanical locomotion with time's arrow in his boxed-in universe of flying gaseous particles will not really do—the crank can still be turned the other way. If time is infinite, then the most outrageous and improbable thing will eventually happen, and what is worse, may have happened already. We slither closer and closer to zero, but we never find nothing. One almost expects the ghost of Bishop Berkeley to arise and denounce differential calculus as a sleazy, slithery put-on, which indeed it is.

Finally, we come to economics in the last half of the text. This, unfortunately, does not fit very well into the rest of the volume. It would probably better have been published as a separate essay. The concept of entropy flitters like an intellectual ghost around the edges of economics. Economic processes, like evolutionary processes, are entropy-segregating. They build up order out of chaos and the improbable out of the probable. Out of rocks, ores, and clay, soil and water, and fossil fuels, plants, and animals, economic processes create skyscrapers and furniture, automobiles and airplanes, which somehow represent higher levels both of improbability, order, and of value than the damp, cold, hard, drafty, and hungry environment of the world left to itself in the great north woods. If the astronauts had found the simplest commodity on the moon, even an ash tray, it would have symbolized a previous visit by a vastly higher order of being than the dead satellite represents. The temptation, therefore, to equate entropy = order = value is strong, and I have argued myself that an entropy theory of value might be formulated that would throw a great deal of light on the economic processes of development as they stretch out through time and space, and would certainly be more realistic than the labor theory of value. The regrettable fact seems to be, however, that when we try to pile too much on the entropy concept and drag it from its rather limited usefulness in thermodynamics to make it bear the weight of all the "time's arrow" processes, whether in information theory or in economics, it simply breaks under the strain. A measure of disorder does not tell us much about the order which is destroyed, and order is of many levels and stages, of which thermodynamic order is one of the simplest.

Unfortunately, Georgescu-Roegen's work, brilliant as it is, does little to disprove this thesis. I regretfully conclude that the chapters on economics are at a lower level than the rest of the book and are not adequately worked out. They contain some extremely interesting heretical insights and some trenchant criticisms of standard economics, but they also seem to contain some real errors. I am delighted on the one hand to welcome Georgescu-Roegen to the heretical sect, which regards consumption as a bad thing, welfare being measured by the enjoyment of the stock or condition or state rather than by throughput of production and consumption. It is use, not using up, that constitutes economic welfare. I am delighted, also, to recognize in him an economist of the coming "spaceship earth." Nevertheless, when it comes to the theory of production, I would defend the traditional cookbook theory that relates quantities of inputs to quantities of outputs against Georgescu-Roegen's insistence on qualitative uniqueness, for if everything is unique nothing can be said. His overemphasis on continuities leads him into a glorification of the factory system as a continuous process and a failure to recognize that it is discontinuous agriculture which has shown the largest increase in productivity, at least in the last 30 years. So that when he says that technological progress has by and large proceeded at a slower rate in agriculture he is simply wrong. With his attack on "arithmomorphism" in econometrics I have some sympathy, but this does not mean that we should not do it, merely that we should not believe it when it is done. Dialectics, as he uses the word, leads to a useful recognition of the inadequacies of classification, taxonomy,

and arithmetic, but it provides no real substitutes for them. On the whole, therefore, I must confess that I found the economic chapters of the work somewhat disappointing, though in many ways highly suggestive and interesting. One hopes that the author will go on to develop these chapters into a major systematic work.

In spite of some very real defects, this is a remarkable book, just as Georgescu-Roegen is an extraordinary man. I know of no one in the intellectual community who achieves his level of competence and creativity in both the physical and the social sciences. One could almost found a sect with the sole purpose of producing a Talmud on him, of criticism and expansion. This is not a book that may appeal to a very wide circle of readers. If, however, the right 500 people were to read it, science perhaps would never be quite the same again.

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A Study of Intellectual Change

Freud and the Americans. The Beginnings of Psychoanalysis in the United States, 1876–1917. NATHAN G. HALE, JR. Oxford University Press, New York, 1971. xvi, 574 pp. $15. Freud in America, vol. 1.

Thomas S. Kuhn's "paradigm" model of scientific innovation has been applied mostly to the physical sciences, within which systems and ideas have been relatively well defined. Now Nathan G. Hale, Jr., a historian, would like to apply Kuhn's model to the historical process by which psychoanalysis penetrated into American culture. Hale, however, wants to use, instead of cognitive systems, "styles," in the sense of life-style now familiar in personality theory. Freud's teachings came in, Hale suggests, just when a completely somatic view of human behavior and personality was at the height of a crisis, the Kuhnian stage preliminary to a scientific revolution. Freud, according to Hale, provided the model by which medical psychologists and other intellectuals could reintegrate their conceptualizations. Present-day scholars who have been uncomfortable with what they perceive as looseness of definition of Kuhnian paradigms will hardly welcome the use of an even vaguer and slipperier concept, style, even though Hale's extension may be entirely in keeping with the psychological-sociological level of discourse appropriate for discussing paradigms.

Nor would Hale reassure anti-Kuhnians by associating with his first theme a second, that Freud was taken up by the vanguard of another revolution, that of "the repeal of reticence" about sexual matters. Although, Hale maintains, reticence and the somatic style were subtly interconnected in the minds of turn-of-the-century Americans, changes in sexual attitudes stray far from the neat models of scientific ideas with which Kuhnians are familiar. Yet Hale's application is in the spirit of the paradigm theory, and style is functional in the same way that crucial problem solving is.

Hale raises these interesting questions as general themes and chapter headings in a very detailed narrative history of a limited subject. With exhaustive coverage of sources he recounts the ways in which Americans came to know and understand the work of Freud and his followers up to about 1920. World War I as a special topic and the 1920's are to be covered in a subsequent volume. The bulk of Hale's exposition is devoted to explaining carefully what was in the European psychoanalytic literature and how American physicians and other literate Americans came to conceptualize it. Freud's American audience often saw his work in terms already familiar, especially philosophical idealism and popularized Darwinism and reductionism. Indeed, Hale suggests that virtually no current of contemporary thinking was irrelevant to Americans' understanding of psychoanalysis. Much of the text is background, consisting of social-intellectual history and Hale's popularization of psychoanalytic ideas.

Two books, at least three doctoral dissertations, and innumerable articles, biographies, and institutional histories have already elucidated much of the early history of psychoanalysis in America. Hale nevertheless chose to start over from the beginning and recapitulate details, especially how the congeries of ideas associated with Freud gained a unique place in both medical and popular writings because of the aggressive crusade carried out by such proponents as the sensitive and idealistic puritan James J. Putnam of Boston and the dedicated immigrant A. A. Brill of New York. Hale does offer many incidental insights as he explores the interplay of idea, personality, and historical change, and a leisurely reader will find these byways rewarding. But in the mass of specifics Hale's chief themes, somaticism and sexual liberation, do not come through with the clarity and consistency they deserve. They remain tantalizing suggestions that Kuhn's model of change may be more broadly applicable to history than most thoughtful students of intellectual change have seen clearly heretofore.

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Cultural Ecology

Amazonia. Man and Culture in a Counterfeit Paradise. BETTY J. MEGGERS. Aldine-Atherton, Chicago, 1971. x, 182 pp., illus. Cloth, $7.50; paper, $2.95. Worlds of Man series.

Betty J. Meggers, who has undertaken the only extensive archeological research in northeastern Amazonia, has for many years been concerned with the relationship of tropical forest environments and human societies in South America. More particularly, she has advocated the view that the South American tropical rain forest is an unsuitable environment for the development and persistence of societies characterized by internal complexity, high population density, and intense agricultural exploitation. Her latest book, *Amazonia*, can in fact be considered an attempt to demonstrate why this is so.

In general, however, the aims of the book are to specify variables influencing cultural adaptation in the Amazon basin and to present a set of general principles constituting a theory of cultural evolution. Meggers has countered the usual dearth of environmental detail characteristic of cultural ecological theory concerning the Amazon basin with extensive descriptions and provocative hypotheses about the constraints and requirements imposed upon human society by particular features of the habitat. For this reason, the book should be read by all who wish to understand, modify, or preserve the tropical forest environment.

The premise of *Amazonia* is that of cultural ecology in general, namely, that "the similarity in the behavior of biological and cultural phenomena indicates that the same processes underlie both cultural and organic evolution" (p. 161). Culture is an adaptation (but also determined by adaptation) guided