Vignette: On Theory

Theories are ways of looking at things. A *theoros* in ancient Greece was "a spectator, an observer, one who travels to see men and things; an ambassador sent by the state to consult an oracle, or to observe the games." But that etymology makes it clear that theories cannot be just casual ways of looking: there is something ceremonial, almost official, about any view of the world which qualifies as a theory. Without pressing the point about oracles (or games) we can recognize in the present organization of science a reluctance to dignify with the title "theory" any mere working hypothesis. It was some such reluctance, perhaps, that led the founders of the Society for General Systems Theory to change its name, soon after its establishment, to the Society for General Systems Research. (This modesty did not last—the Society changed its name again, a few decades later, to the International Society for Systems Science.)

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Theories have often been compared to maps in which can be observed a similar selectivity. Railway maps, for example, show only railways, road maps only roads, relief maps only heights above sea level, etc. Each map is useful primarily for the specialized information it conveys. Each map contains also, it is true, hints about the country in question not directly related to its primary function. From curves in the track, and the positions of termini, bridges, and tunnels, it is possible to get a good deal of topographical information out of a railway map, although it is not the business of railways to describe the territory they traverse. They have, however, to conform to it more or less narrowly according to the available resources of civil engineering, and that necessity builds information about it into them. Similarly, airline maps give a good deal of information about population density, although here there is a danger that a refueling stop in the middle of an ocean may look like a large city.

—*Peter Caws*, in *Yorick's World: Science and the Knowing Subject* (University of California Press)

more ecologically responsible in their day-to-day lives.

A China that is neither a capitalist market economy nor a centrally planned socialist economy is one whose institutions generate very mixed messages with regard to the environment. The "get rich quick" mentality that currently characterizes much of the economy and the corrupt uses of political power for economic gain often encourage careless, exploitative behavior with regard to the environment. On the other hand, the reformist movement (however slow) toward prices that reflect scarcity values and the gradual emergence of new institutions providing a risk-management infrastructure for a capitalist society—such as insurance schemes and liability law—should, over time, encourage greater environmental responsibility.

A second set of questions concerns the international implications of the environmental quandary described by Smil. At various points in the study, Smil alludes to these—as in his discussion of the CO_2 problem and the possibility of ameliorating degradation through more efficient technologies from abroad (his discussion of irrigation technologies, for instance, is intriguing). Given the nature and extent of China's problems and the levels of support that could be expected from the international community, Smil is not sanguine that enhanced international cooperation will make a major difference in retarding degradation. This is clearly an area to be watched, however. The growing emphasis placed on the environment in China's relations with international organizations (especially the World Bank) and with foreign governments, the pressures placed on China by nongovernmental organizations, and the obligations China incurs by its participation in emerging international environmental regimes all ensure that China's domestic environmental technology and policy choices increasingly will be conditioned by international influences.

With the potential for creating serious international ecological problems, which may also become disruptive politically, China's environmental difficulties are inescapably matters of international concern. The maintenance of an ongoing constructive engagement with China on environmental matters thus looms as an important foreign policy challenge for the United States and for other Western countries. Though not addressed directly by Smil, questions of foreign policy and international environmental diplomacy are unavoidable in light of his account. For these reasons *China's Environmental Crisis* can be read as strengthening the case of those (many of whom may be uneasy with the narrow and increasingly unproductive terms of post-Tiananmen U.S. policy toward China) who would put environmental matters into a more central place in U.S. thinking about China.

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Symbioticists Rediscovered

Concepts of Symbiogenesis. A Historical and Critical Study of the Research of Russian Botanists. LIYA NIKOLAEVNA KHAKHINA. Lynn Margulis and Mark McMenamin, Eds. Yale University Press, New Haven, CT, 1993. xxxii, 177 pp., illus. $35 or £22.50. Bio-Origins Series. Translated from the Russian edition (Leningrad, 1979) by Stephanie Merkel and Robert Coalson.

This slender volume opens a long-closed window into a body of work largely unknown to the Western scientific public. The subject of the book is the work of Russian botanists pertaining to theories of symbiogenesis from the late 19th through the early 20th century. "Symbiogenesis" is the term devised by K. S. Merezhkovsky to describe the evolutionary origin of organisms through symbiosis. The book itself resembles a Russian doll: stories within stories are revealed as one reads from the foreword to the appendix, starting with the spy-novel–like episode in which the Russian version of the book came into Lynn Margulis's possession, slipped into her hand by an unknown woman in a crowd after a lecture in Moscow.

The book begins with a foreword by A. Vucinich pointing out the importance of lichens in tundra ecology and the profound influence of the study of lichen symbioses on Russian botany, followed by a lively preface by Margulis and M. McMenamin describing how the book came to be translated and published in the United States. Khakhina's book, edited to update terminology, follows. Originally published in 1979 in Russia, it consists of an introduction setting out the author's intent and approach and summarizing the develop-

ment of symbiogenesis theories, followed by chapters describing the work of A. S. Famintsyn, K. S. Merezhkovsky, A. A. Elenkin, and B. M. Kozo-Polyansky and a chapter covering the views of half a dozen Russian workers in the 1920s through 1940s, and concludes with a rather dated review of modern concepts of symbiogenesis. A key theme is the complex interplay between Darwinism and symbiogenesis.

Khakhina is a proponent of the theory of symbiogenesis, and the purpose of the book appears to be to bolster the legitimacy of the field by searching for the precursors and precedents of modern ideas. She seeks to dispel the notion that contributors to the field were scientifically disreputable and to establish that they form a coherent tradition. Her analysis is done from the standpoint of how accurately these scientists foreshadowed currently prevailing views. This approach to the history of science, viewing science of the past primarily through the lens of current scientific consensus, has long since gone out of fashion among academic historians of science.

The more conventional approach, that of analyzing science and scientists within the prevailing intellectual, sociological, and political context, is employed in the appendix by D. C. Mehos on an American proponent of symbiogenesis, Ivan Wallin. Placing the contributions of Wallin in their full context provides considerable insight into the reasons his ideas had so little impact, which in this case were both scientific and cultural. This essay also provides some insight into the decidedly negative response of the scientific establishment to Margulis when she came forward decades later.

The sociopolitical context of the book is as interesting as the book itself. There is little evidence that Russian symbiogenesis research and ideas were well known in the West, and thus it appears that they did not greatly influence the research in this area that has led to the widespread acceptance of some of the key concepts of symbiogenesis. Why then should a synopsis of the work of now obscure Russian botanists merit the spotlight?

In the 1960s Lynn Margulis became a strong proponent of the notion that cellular organelles have a symbiotic origin. Her advocacy was based on ultrastructural and genetic evidence but preceded the accumulation of molecular data that make the current generation of biologists accept the symbiotic origin of mitochondria and chloroplasts as virtually self-evident. She has maintained her position at the leading edge of controversy by proposing that other organelles, such as eukaryotic cilia, flagella, and centrioles, also have symbiotic origins and by strong support of James Lovelock's Gaia hypothesis.

Initially, her views were heavily criticized and largely rejected, and she was ostracized by many mainstream scientists. As evidence accumulated in support of the symbiotic origin of organelles, particularly mitochondria and chloroplasts, Margulis was criticized for not giving adequate credit to her intellectual antecedents. Margulis's efforts to bring this book to publication serve several purposes. She is able to make amends for any past neglect of her historical predecessors and enhance the historical dimension of the field. The book also provides her with some intellectual soulmates and celebrates a shared vision.

The chief virtue of the book is that it makes this interesting group of Russian scientists and their work known to the Western scientific public. As historical scholarship, Khakhina's book leaves something to be desired, but it makes enjoyable reading nonetheless. Above all, it whets the appetite for a thorough treatment of the modern era in the West.

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Other Books of Interest

Molds, Molecules, and Metazoa. Growing Points in Evolutionary Biology. PETER R. GRANT and HENRY S. HORN, Eds. Princeton University Press, Princeton, NJ, 1992. x, 181 pp., illus., + plates. $32.50 or £23.50. Based on a symposium, Princeton, NJ, Oct. 1990.

This volume results from a symposium held to honor John Tyler Bonner on his retirement as professor of biology at Princeton University. Noting that Bonner began his career at Princeton at the time of an international conference there that marked the birth of the Modern Synthesis of evolutionary fact and theory, the editors have brought together for publication a set of papers on evolutionary themes. The first of these is by Bonner himself, who reiterates his view that "evolution by natural selection is the most useful, the most important, the most all-enveloping concept in all of biology" and traces "with a very light brush" the changes over the last 50 years in paleontology, ecology, behavior, development, cell biology, and molecular genetics that are relevant to evolutionary thought. These fields are then in turn each represented by an essay. On paleontology, James W. Valentine notes the trend of the field, once a province of geology, toward biology and discusses three areas in which its contribution of a historical view is important for biology—the origin and early radiations of metazoan body plans, taxonomic turnover rates among phyla and classes, and the composition of marine benthic paleocommunities. On ecology, Graham Bell identifies and discusses five "properties of the environment" that are of general theoretical interest—variability, spatial and temporal complexity, inconsistency of organismal responses, self-regulation of variation, and a tendency to deterioration. Mary Jane West-Eberhard takes up the issue of behavior and evolution, predicting greater concern with epigenetic phenomena and the emergence of "a new mode of experimentation" aimed at discerning how new adaptive behaviors can emerge from ancestral phenotypes. Leo Buss and Matthew Dick present a case for the study of development as the "middle ground" of biology, between molecules and organisms, reviewing the history of the subject and advocating the potential of a focus on life cycles and the experimental approach of saturation mutagenesis for putting development into an evolutionary context. With regard to cell biology, Mark Kirschner, in light of accumulating evidence for conservatism in the evolution of the eukaryotic cell, sees the promise of the study of evolution as lying in the understanding of operating systems, or "collections of software." In the final chapter, Martin Kreitman explores the relationship between molecular and evolutionary biology and the limitations of the former—categorized as technical, theoretical, epistemological, and economic/political—for a full understanding of evolution. An epilogue by Grant, a combined reference list, and an index conclude the volume.

—Katherine Livingston

"Most of the Good Stuff." Memories of Richard Feynman. LAURIE M. BROWN and JOHN S. RIGDEN, Eds. American Institute of Physics, New York, 1993. vi, 181 pp., illus., + plates. $35.

The colorful and by all accounts brilliant physicist Richard Feynman, who died in February 1988, was the subject of a memorial symposium at the subsequent AAAS meeting, and the papers presented there were published as a group in the February 1989 issue (vol. 42, no. 2) of *Physics Today*. Feynman has since been the subject of a major biography (James Gleick's *Genius*, reviewed in *Science* **259**, 537 [1993]). Now to round out the Feynman literature the American Institute of Physics has brought together this collection of "memories." The core of the book is a reprinting of the