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NEW BIOLOGICAL BOOKS

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ORIGINS OF BIOLOGICAL THOUGHT

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A Review of

THE PROBLEM OF LIFE. *An Essay in the Origins of Biological Thought.*

By C. U. M. Smith. Halsted Press (John Wiley & Sons), New York. $19.75. xxiv + 343 p.; ill.; index. 1976.

This book is truly a remarkable achievement. It is an essay of great depth and insight, and one that should be read and reread by all students of science, especially biological scientists. As important as this book is, however, I predict that it will not be widely read by biologists. Most biologists unfortunately do not reflect much on the origins of biological thought, preferring instead the concepts of today. But Smith's cogent analysis of the origins of biological thought may help stimulate interest in the roots of our disciplines.

The essay centers around Shelley's plaintive cry from *The Triumph of Life:* "Then, what is life?" Though this question is at the core of all biological investigation, it is also true that philosophers, theologians, poets, chemists, and physicists have pondered the same question. And herein lies one of this book's fascinations: we see biological thought emerging as a complex fusion of seemingly disparate and often contradictory concepts. The matter of life was and still is to many people far more than DNA replication, ATP, and natural selection. Biology has grown out of a rich and varied background, yet it is still very much influenced by that background. We need not look very far today to see how society's views of life influence our discipline.

The approach that Smith chooses to take in this book should appeal to a wide spectrum of readers. He actually employs three approaches: he examines isolated historical epochs such as Aristotelian biology, Cartesian biology, and Naturphilosophie; he also examines more specific biological concepts as they have developed through time; and he shows how social, historical, and economic forces have shaped and continue to shape biological science.

Throughout this book Smith attempts to show how life has been viewed at different stages of scientific development. The progress of biological thought through time is seen as a gradual separation of the teleological from the nonteleological; the bifurcation of objectivity and subjectivity.

Of paramount importance to the development of a mechanistic biology was the idea of random collisions between the atoms composing all matter. If such randomness was the case, then the teleological view of life with its purposes and final causes was considerably weakened. Ideas germane to the atomic theory existed in the early Greek world around 500 B.C. But such a mechanistic view of life, attributing such things as sound, smell, love, ambition, and honor to the whims of purposeless atoms was more than the Greek world would long permit. Aristotle's biology was decidedly teleological, as was Galen's and Harvey's after, and these are among the world's greatest biologists. The idea of atomic theory was effectively repressed from ancient Greece and remained so until the advent of the 17th century A.D. Social conditions were such that further advancement of the atomic theory or an atomistic view of life was impossible until the 17th century.

Just as social forces can repress ideas, so too can they blow the breath of life into them. Post-17th century society was more conducive to an atomistic interpretation of life. Hobbes, for example, described the behavior of the state in terms of atomism. Society emerged as the result of "blindly running," "nasty and brutish lives." Society was essentially a consequence of random movements of the individuals that compose it. Malthus and Darwin were mechanistic in their writing. But perhaps the single most important development favorable to a mechanistic way of thinking was the emergence of a modern technology. Technology stimulated mechanistic thinking, which in turn stimulated technology.

It was Descartes, a 17th century contemporary of Hobbes, who previewed the mechanistic vision of life. Descartes' *L'Homme* is a marvel of non-teleological thinking, but it could only be fully appreciated after Darwin, when purposelessness was more a part of people's thinking.

Smith explores and elaborates upon these ideas in twenty-two chapters, beginning with the part played by the human imagination in scientific theory and ending with a scientific examination of the mind's functions. In the first chapter, the parallels between creativity in the arts and sciences are discussed. Clearly, the creative impulse is the same.

The material in chapters 1, 2, and 3 lays the foundation for what follows. In chapters 2 and 3 the modes of thought of the primitive world are explored, a world of magic and superstition. In this world, Smith points out, creativity is involved in interpreting life, and he shows how closely intertwined subjective and objective views are. He examines the paleontology of some key terms in our biological lexicon to show how they have evolved and how their connotations have changed. Terms such as action, energy, movement, nature, and cause were usually far richer in their meaning than they are today.

The analysis of early Greek science begins in chapter 4, and continues through chapters 5 and 6. Around Miletus, along the eastern shore of the Mediterranean, a group of early Greek thinkers were establishing themes destined to live on for centuries. Between 750 B.C. and 550 B.C., Greek colonies were being established along the Italian shore, and these colonies produced some of the world's most famous names in science and philosophy: Pythagoras, Empedocles, Xenophanes, Parmenides. The colonies along the Italian shore were more teleological and introspective than their forerunners from the eastern Mediterranean shores of Ionia. Smith speculates that this may have been causally connected to the defeat of the Ionian king, Croesus, by the Persian emperor, Cyrus. In chapters 4 and 5 we get a clear assessment of pre-Socratic thinking, and chapter 6 details how the concept of atomism is introduced into the thinking of the early Greeks, largely by Democritus.

In the next part of the book, Smith examines how social conditions influence scientific thought. He does so by assessing the powerful influence of Socrates, his disciple Plato, and Plato's stellar pupil, Aristotle. Socrates is protrayed as striving to save the Athenian democracy from demagogues. He diverted philosophers' attention from phenomena of the macrocosm to the analysis of the microcosm — the human spirit — and he disdained discussion of the nature of the Universe and how it works. Instead, he encouraged discourse on social organization and politics, and argued that every man possessed immutable forms of qualities such as virtue, justice, and statesmanship, and that these forms were inherent at birth.

Plato voices this teleological view of life in his dialogues, and Smith examines it as presented in the *Timaeus*. The teleology of Plato is in sharp contrast to the mechanism of Democritus. In Aristotle, the Platonic influence is much in evidence. Smith examines Aristotle's biology, physics, and metaphysics and finds a teleological undercurrent coursing through his writing. He attempted to imbue inanimate nature with animate qualities, seeing essentially no dichotomy between the animate and inanimate. But Aristotle devoted his life to examining the question of "what is life?," and he probably is the greatest of all thinkers who have ever pondered this question.

Following his analysis of the Aristotelian view of life, Smith essentially skips over the next two thousand years of intellectual history (four chapters, 57 pages). He justifies this by arguing that Aristotelian thinking dominated this entire time span. He also is admittedly and unfortunately constrained by the spatial limitations of the book. But Smith does cover in those four chapters some salient developments during this period that heralded the way to the mechanistic views of Descartes. He discusses alchemy and suggests that it involves the misapplication of concepts derived from biological and psychological observations to the inanimate world. Then he shows how the gradual development of a technology enabled investigators to begin liberating themselves from the constraints of the alchemist point of view. Galileo's insights were crucial here to promulgating a mechanistic interpretation of life.

Descartes' visions of life mark a pivotal point in the dichotomy of objectivity and subjectivity. His view of the human animal was thoroughly mechanistic, and this view is explored in chapter 15. Once the basic revolution in the chemical sciences began in the 18th century, Descartes' mechanistic physiology assumed a position of fundamental importance.

The debate over "man the machine" and "man the maker of machines" raged on long after Descartes. It continues today. Is the human being nothing more than the product of an engineering God? Certainly many felt and continue to feel that life cannot be understood on the basis of chemistry and physics alone.

The emergence of Darwinism is seen by Smith as addressing part of the problem. Darwinism provided a clear answer to the problem of human origins, and the science of genetics gave Darwinism the mechanisms it required to support the theory. But Darwinism, even when fused with Mendelism, has not completely overcome opposition to a teleological interpretation of Shelley's question.

In the last two chapters, Smith extends the mechanistic view of life to embryology and neurobiology. Both of these areas, especially the latter, have always been major obstacles in the progress of mechanistic biology. Many of the shrouds covering development have been removed as we come to understand more and more about gene regulation. But neurobiology has not yet permitted a purely mechanistic analysis. Few believe that major paradigms in neurobiology will not be forthcoming, but for now they remain obscured.

As the book concludes, we see that the dichotomy still exists today in our understanding of life. We tend to view the world mechanistically, but we view ourselves more teleologically. We still have no satisfactory answer to Shelley's question, but the search continues, and Smith's eminently readable and thought-provoking essay can only help to give us pause in our routine and inspire us to ponder the issues.

Considering the objectives set forth by the author, this book succeeds with distinction. It is destined to become a classic.

A WHITE QUEEN SPECULATION

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THEORETICAL ECOLOGY: PRINCIPLES AND APPLICATIONS.
Edited by Robert M. May. W. B. Saunders Company, Philadelphia. $13.50. viii + 317 p.; ill.; organism and subject indexes. 1976.

In a recent meeting with a physiological ecologist whose work I greatly admire, I explained that my visit to his university revolved around mathematical models of red tides. He became thoughtful, and after a pause inquired gingerly "do we know enough about these things to model them yet?" Later I discussed the same topic with a field biologist expert on red tides, and he said bluntly, "I can't use these models to predict anything." I recall, on another occasion, similar skepticism from a well-known biochemical parasitologist when I showed him a preprint of a mathematical model of schistosomiasis by an (equally well-known) mathematical ecologist. Thumbing through pages of equations, he asked simply "how does one justify support for such work?" The bottom line, so to say. And these are by no means isolated instances. Perpaps then the time is ripe for a bit of ecological soul-searching if we are to respond to such questions.

Is there a theoretical ecology? If there is, what is it good for? Presumably the answers are in this book. Much has happened in eight years since Bob May started doing ecology. Vague questions have been stated more clearly as biologists became aware of mathematical tools; in turn, as the problems became less obscure, more mathematicians, engineers, and physicists have been led to study ecology on its own terms. Many of the authors in this collection are associated in one way or another with May's work — it is overstating it to speak of a "Princeton school" of ecological modelling, but there is certainly a distinct current of thought, well represented here. There are 14 essays, as follows: Introduction, R. M. May; Models for single populations, R. M. May; Bionomic strategies and population parameters, T. R. E. Southwood; Models for two interacting species, R. M. May; Arthropod predator-prey systems, M. P. Hassell; Plant-herbivore systems, G. Caughley; Competition and niche theory, E. R. Pianka; Patterns in multispecies communities, R. M. May; Island biogeography and the design of natural reserves, J. M. Diamond and R. M. May; Succession, H. S. Horn; The central problems of sociobiology, E. O. Wilson; Paleontology plus ecology as paleobiology, S. J. Gould; Schistosomiasis, a human host-parasite system, J. E. Cohen; Man versus pests, G. Conway.

This isn't a textbook. There is little attempt to derive mathematical statements, and one is usually referred to the literature for proofs. Chapters 2 to 4 deal with implications of well-known simple deterministic models governed by two parameters — the