BOOKS: ORIGINS OF LIFE

Old Views of Ancient Events

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Thoughts about the origin of life have changed in the 1990s as fresh data and ideas have opened new approaches to tackle this old problem. These changes are only the most recent transformation of the question of "origins." The Biblical model (Genesis) was transformed by textual analysis of the Bible itself in the 19th century. Explanations metamorphosed again with the emergence of Darwinian biology, and yet again when the chemistry of genetics was defined in the 1950s. Chemists then asked what organic molecules might emerge from nonliving matter via nonliving agents (sparks, ultraviolet light, and the like). The discovery of RNA catalysis in contemporary biology by Cech, Altman, and their co-workers gave support to an older idea that a single biopolymer, perhaps RNA, might have served both genetic and catalytic roles in an early version of life. This hypothesis avoids the "chicken-or-egg" problem arising from modern metabolism, in which proteins are needed to make DNA and DNA is needed to make proteins. Courageous groups began efforts to get RNA to reproduce itself.

The Molecular Origins of Life
Assembling Pieces of the Puzzle
André Brack, Ed.
Cambridge University Press, Cambridge, 1999. 427 pp. $85, £65. ISBN 0-521-56412-3. Paper, $34.95, £22.95. ISBN 0-521-56475-1.

Despite their sophistication, these—dare we call them "classical"?—approaches did not solve the problem surrounding life's origin. Prebiotic chemistry could produce a wealth of biomolecules from nonliving precursors. But the wealth soon became overwhelming, with the "prebiotic soups" having the chemical complexity of asphalt (useful, perhaps, for paving roads but not particularly promising as a wellspring for life). Classical prebiotic chemistry not only failed to constrain the contents of the prebiotic soup, but also raised a new paradox: How would life (or any organized chemical process) emerge from such a mess? Searches of quadrillions of randomly generated RNA sequences have failed to yield a spontaneous RNA replicator. This failure raises new questions: Will the elusive replicator emerge after we examine quintillions of random sequences? Or must we add something to RNA to be successful? Researchers have prepared a number of new nucleic acid analogs. With these has come the realization that for a single biopolymer, capable of both genetics and catalysis, to sustain Darwinian evolution, it must be Capable Of Searching Mutation-space Independent of Concern over Loss Of Properties Essential for Replication. This "COSMIC-LOPER" behavior is now known to be scarce in molecular systems.

The developing paradigm offers potential. Genome sequencing projects now make it possible to reconstruct the sequences of proteins from ancient organisms by maximum likelihood methods and to prepare these extinct proteins in the laboratory, allowing an assault on the "origins" problem by strategically working backwards from the present day. Paleontologists have discovered fossils that establish more ancient dates for the first multicellular organism and, perhaps, the first cells. Chemists are adding functionality to DNA and RNA in an effort to increase the modest catalytic power of these molecules and to obtain systems simultaneously capable of both efficient self-replication and catalysis. With support for research coming from agencies as diverse as NASA (Astrobiology) and the NIH (the Human Genome program), these are exciting times for a renewed effort to understand the origin of life.

Remarkably little of this potential is conveyed in *The Molecular Origins of Life*, edited by André Brack (currently president of the International Society for the Study of the Origin of Life and chair of the European Space Agency's exobiology team). The 22 authors, researchers well known in the field, present findings from astronomy, planetology, paleontology, biochemistry, and microbiology. Some of the contributions resemble earlier accounts by the same authors; 15 of the 18 chapters cite earlier papers by their authors that cover much the same material in much the same way. Although it is always good to collect classical ideas in one place, a book at 1999 prices might be expected to also include more of the field's current excitement.

It appears that the book spent a long time in preparation. For example, in 1995 Stanley Miller's laboratory reported a nonbiological reaction that creates a precursor for functionalized RNA (*1*). But this advance is not mentioned in the chapter written by Miller—a surprising omission considering the importance of the discovery to the next phase of origins research.

The chapter by Bill Schopf provides a nice presentation of a "modern" dispute in the field, contrasting the fossil and molecular records in an effort to date key events in the history of the biosphere. Schopf, not surprisingly, favors conclusions implied by the fossil record, and argues credibly for them. His arguments do not differ greatly from those he has previously presented, with equal skill. But without an analysis of the same issue approached from the molecular side, the discussion remains incomplete. A chapter offering that analysis is missing.

The Molecular Origins of Life may find its greatest value by highlighting the inadequacies of the field. Opposing sides frequently argue past each other, failing to engage because they use different logic and different language. Efforts to reconstruct ancient metabolisms by picking and choosing features of modern metabolism are often undermined by the lack of a coherent underlying strategy, and the book contains informative examples of this shortcoming. Those who wish to have the latest word on the "classical" approaches to the origins of life, which have characterized the second half of the 20th century, will find this volume worth purchasing. But let us hope that the next overview of the subject goes farther.

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References

1. M. P. Robertson and S. L. Miller, *Science* **268**, 702 (1995).

BROWSINGS

Molecular Genetics of Plant Development. *Stephen H. Howell.* Cambridge University Press, Cambridge, 1998. 383 pp. $85, £70. ISBN 0-521-58255-5. Paper, $39.95, £24.95. ISBN 0-521-58784-0.

In this text, Howell offers a molecular genetics perspective on life-cycle events (embryogenesis, seedling development, flowering) and the formation of organ systems (roots, shoots, and leaves). He compares plant and animal development and considers the roles of cell lineages and positional information in plants.

The Particle Century. *Gordon Fraser, Ed.* Institute of Physics Publishing, Bristol, 1998. 254 pp. $59.50, £30. ISBN 0-7503-0543-6.

Cosmic rain, quarks, gauge theories, weak interactions, and the standard model are among the topics covered in this series of essays. The authors, primarily particle physicists and cosmologists, describe the development and implications of 20th-century discoveries that have probed successively smaller constituents of matter.