

BOOKS

On the Emergence of Life, Terrestrial and Otherwise

Stepping Stones: The Making of Our Home World

▶ Stephen A. Drury
Oxford U. P., New York, 1999.
432 pp. \$35.00 hc
ISBN 0-19-850271-0

The Search for Life on Other Planets

▶ Bruce Jakosky
Cambridge U. P., New York, 1998.
336 pp. \$64.95 hc (\$20.95 pb)
ISBN 0-521-59165-1 hc
(0-521-59837-0 pb)

Planetary Dreams: The Quest to Discover Life beyond Earth

▶ Robert Shapiro
Wiley, New York, 1999. 306 pp.
\$27.95 hc ISBN 0-471-17936-1

Received by Andrew H. Knoll

In 1976 two Viking spacecraft landed on Mars. Sent to search for life, they revealed instead a forbidding landscape, unlikely to support biology. Interest in extraterrestrial life, brought to full boil by Viking's launch, was left to simmer on a decidedly back burner. It didn't cool completely, however, in part because of images supplied by Viking itself. Channeled landscapes and other geomorphological features indicate that four billion years ago—about the time that life emerged on Earth—Mars was not the bleak pile of rocks observed today but rather was a planet blessed with liquid water, active volcanoes, and, in consequence, widespread hydrothermal systems. Four billion years ago Mars may have been a habitable planet.

Biological interest in the solar system, sustained for two decades by a small but committed band of scientists, returned to prominence in 1996 with the publication of the extraordinary claim that ALH-84001, a grape-

fruit-sized meteorite from Mars, contained evidence of an ancient Martian biota. Astrobiology was reborn, and despite widespread skepticism about the meteorite story, space exploration is likely to continue to have a biological cast for years to come. Three recently published books mark this sea change.

Most Earth-bound of the three is Stephen Drury's *Stepping Stones*, a history of the Earth organized around the theme of biological evolution. Long ignored as an epiphenomenon by geochemists and geophysicists who were focused on planetary differentiation, biology is now viewed as a critical component of Earth's surface system. Drury's exegesis of this new worldview begins with serial introductions to fluid circulation, biochemistry, plate tectonics, and Milankovitch cycles.

His explanations are lucid, but would be demanding for a general readership. (Drury's target audience is not always clear). Armed with knowledge of interacting biological and physical processes, the reader is taken on a tour of Earth's history, from the emergence of life to the rise of technological humans (poisoned, in Drury's view, by capitalism). Drury is strongest when reconstructing geological events from field evidence. His accounts of biology and paleobiology are generally good, although not free of error. To cite one example, his digest of Cambrian animal diversification is inexplicably muddled, advancing, among other things, the demonstrably false notion that carbonate rocks were rare before the evolution of skeletons. Astrobiology *per se* gets little notice, except in cynical dismissal: "But even if Mars did once host life, so what?"

So what, indeed! If life is born of planetary processes, then it may arise wherever the right conditions obtain. And if biology can emerge through time as a set of globally important processes in its own right, we are encouraged to think that, where it is persistent, life will leave an interpretable signature. This logic is laid out clearly in Bruce Jakosky's contribution. Written as a textbook for undergraduate courses in astrobiology, *The Search for Life on Other Planets* provides a well-illustrated guide to

the biological universe. To skeptics, that universe consists of Earth and speculation; to Jakosky, it comprises Earth and exploration.

Like Drury, Jakosky begins with rudiments of Earth science and biology, but he quickly moves on to Mars, summarizing Viking results and the ALH-84001 debate. Future exploration of Mars is given brief but positive notice, as is the more debatable prospect of altering the surface of our planetary neighbor to make it more Earth-like. Venus, Titan, and, of course, Europa, round out the tour, garnished by musings on intelligence and philosophy. So much for the "so what?" of Drury.

Jakosky's book will serve courses well, but it is not a volume that I would expect to kindle excitement in my next-door neighbor about astrobiological exploration. For that, there is Robert Shapiro's *Planetary Dreams*. Shapiro is the best communicator of the three, and it shows in his lively discussions of two nearly incomprehensible things: time and space. An origin-of-life skeptic, Shapiro is more impressed by the lacunae in our understanding than by experimental insights. Despite this, he sees life as the expected outcome of planetary processes that are thought to occur widely in the universe. Those who view life as the rare product of improbable events are lampooned as "sour lemons."

Of course, given a sample population of one, it isn't clear whether it is logic or faith that separates the two camps. Shapiro advances astrobiological exploration as a means of settling the issue, but there is a problem: The biology most likely to be widespread in space is microbial, but we can search for microorganisms or their biogeochemical effects only in our immediate astronomic neighborhood. Astrobiological exploration of the broader universe is limited to a search for intelligent life, certainly a relatively—and possibly absolutely—rare phenomenon.

That multibillion dollar programs have political as well as scientific dimensions is acknowledged but not convincingly addressed by Shapiro. He ascribes post-Viking decay of planetary exploration to congressional budget cuts, although NASA was well

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