Book Review

Echoes of Life: What Fossil Molecules Reveal About the Earth's History, Susan Gaines, Geoffrey Eglinton and Jürgen Rullkötter (Oxford University Press, 2009), 376pp., ISBN: 9780195176193, $35, (hardcover)

Reviewed by Mindy Levine, Massachusetts Institute of Technology, Department of Chemistry, Cambridge, MA 02139

Where does oil come from? How did ancient cultures preserve mummies? What is the cause of deadly "red tides" in oceans?

The answers to these wildly disparate questions (and many more) are found in the book *Echoes of Life: What Fossil Molecules Reveal about Earth's History* by Susan Gaines, Geoffrey Eglinton, and Jürgen Rullkötter. The book provides an overview of the various scientific fields in which "fossil molecules" can provide key information and understanding about ancient earth. It is not, however, a rigorous scientific text; nor is it a text for the non-scientist. Rather, the book combines anecdotes about the scientists with actual stories of scientific discovery. The result is a narrative that, for the most part, succeeds in entertaining readers while conveying knowledge of an intriguing and constantly evolving scientific field, that of organic geo-chemistry

The book is divided into eleven chapters:

1. Molecular Informants: A Chang- ing Perspective of Organic Chemistry

2. Looking to the Rocks: Molecular Clues to the Origin of Life

3. From the Moon to Mars: The Search for Extraterrestrial Life

4. Black Gold: An Alchemist's Guide to Petroleum

5. Deep Sea Mud: Biomarker Clues to Ancient Climates

6. More Molecules, More Mud, and the Isotopic Dimension: Ancient Environments Revealed

7. Microbiologists (Finally) Climb on Board

8. Weird Molecules, Inconceivable Microbes, and Unlikely Environmental Proxies: Marine Ecology Revised

9. Molecular Paleontology and Bio- chemical Evolution

10. Early Life Revisited

11. Thinking Molecularly, Anything Goes

Each chapter covers one area in which organic geochemistry has provided an improved scientific under- standing. For example, Chapter 4 investigates how the study of "fossil molecules" has improved our understanding of the source of petroleum, and how different environmental conditions can impact oil production. Chapter 5 discusses fossil molecules that have been discovered in deep-sea sediments, and what such molecules indicate about the atmospheric conditions on early Earth.

A key premise of the book is stated explicitly in Chapter 9, "that a lot of genetic variation, and, presumably, evolutionary diversification can occur before it is expressed in morphological traits (page 229)." Scientists have historically studied fossils of ancient organisms in their quest to understand evolution. However, by studying ancient molecules and their prevalence throughout Earth's history, one learns that much about ancient organisms and their biochemical pathways is constantly evolving and changing. Only a small part of this change is captured successfully in morphological changes that can be detected in actual fossils.

The book is liberally sprinkled with tangential observations about scientific research. For example, scientist James Maxwell commented on how scientific research has changed since the 1960s. "Nowadays people have to focus on what they want to do because they've got to justify the money to someone who's got the whip on their back," Maxwell said, "But in those days you did what you wanted and you were just desperate to find out something new. Afterwards, in some cases – and it may have been luck, intuition, it may have been something else – it led to something. But most of the time you weren't aware of that (page 59)."

The authors highlight the sometimes-tense relationship between academic and industrial chemists. At annual Gordon Conferences, for example, the authors report that academic chemists willingly shared their research, whereas industrial chemists "would sit quietly in the back, eagerly soaking up whatever hot new ideas and information the academics had to offer, while the academics fumed because they suspected the industry scientists of

harboring precisely the information and samples they needed to answer the questions at hand (page 81)."

While the book is overall a compelling read, there are a few shortcomings. First, the attempts to provide the necessary scientific background to non-scientists can verge into the overly simplistic and condescending. For example, when the authors describe the theory behind mass spectrometry, they write, "The mass spectrometer is... based on a rather juvenile impulse: the best way to see how something is put together is to break it apart (page 23)." Later in that paragraph, the authors compare mass spectrometry to shattering a tray of wine glasses, which is an analogy that may or may not hold true.

Moreover, the authors are telling a story of primarily *their* scientific discovery, of *their* encounters with other scientists, of *their* thoughts and of *their* research. The research of other scientists is covered in some detail in the various chapters, although many of these other scientists are those whom the authors know personally through various scientific conferences. As a result, the authors may completely ignore research performed by other scientists.

In particular, the chapter on meteorites, "From the Moon to Mars: The Search for Extraterrestrial Life," discusses the various amino acids found on carbonaceous meteorites such as the Murchison meteorite, which fell in 1969. The research of marine chemist Professor Jeffrey Bada at the Scripps Institution of Oceanography is highlighted. Professor Bada investigated reports that the amino acids found on the meteorites contained some degree of L enantiomeric excess (*ee*), and concluded that such findings were likely a result of terrestrial contamination of the meteorite samples.

While this conclusion of Professor Bada's is reported in the book, the book ignores the large body of recent research that supports the opposing argument: that the amino acids found on the Murchison meteorite are extra- terrestrial in origin, and that the L *ee*'s are legitimately extra-terrestrial as well. For example, Professor Sandra Pizzarello has studied the isotopic composition of meteoritic amino acids to address this precise question; her research is not covered.

It is understood that organic geochemistry is an exciting and rapidly changing field of research, and that one book cannot cover the comprehensive body of research. However, the authors do a disservice to their readers by failing to cover both sides of this still-unsettled scientific debate.

In conclusion, this book is structured as a light-hearted narrative in the field of organic geochemistry. It is highly successful in providing an overview of organic geochemistry for the non-specialist, and is recommended for anyone interested in learning more about this exciting interdisciplinary field.