

The Symbiotic Habit

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BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

and other countries, *Inside the Human Genome* is a timely and important work. Significantly, it does not fall into the trap of demonizing religious thought as hopelessly antithetical to science. Echoing the sentiments of geneticist Francisco Ayala, the author describes evolution as a form of “philosophical salvation” to theologians as a means of helping them approach and possibly solve the problem of theodicy. This suggestion may earn *Awise* the scorn of those who see religious faith as the primary problem facing the scientific enterprise today, but it is nonetheless a sound and sensible response to those who fear evolution primarily for its religious implications. It also makes good philosophical sense.

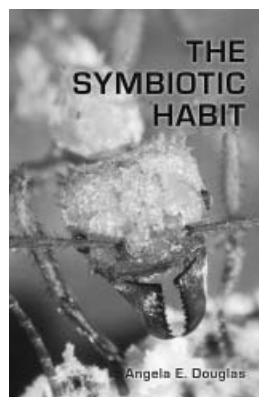
I harbor no illusions that this fine book and its depictions of the non-intelligent design in the human genome will make the ID movement go away. Its hard-core advocates will no doubt shrug off the flaws and wasteful imperfections of the genome and find a way to cling to the concept of design despite the facts. As one of them once told me, “We all know that the Ford Edsel was a badly designed car, but it was still designed.” Nonetheless, the ID movement has advanced, in part, by publicly promoting a buffed-up pseudoscientific caricature of our genetic makeup that emphasizes its complexity, grace, and elegance. As *Awise* has clearly shown, like the other claims of the design-creationist movement, this caricature bears no resemblance to reality.

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SYMBIOSIS

The Symbiotic Habit. Angela E. Douglas. Princeton University Press, 2010. 214 pp., illus. \$45.00 (ISBN 9780691113418 cloth).



Angela E. Douglas, a professor of insect physiology and toxicology at Cornell University, begins *The Symbiotic Habit* by asking the reader to look out the window and recognize that every organism is a product of symbiosis: green plants, plant-eating vertebrates, and even all eukaryotic cells. But this book is about far more than the ubiquity of symbiosis; Douglas discusses the evolutionary and ecological factors that lead to the establishment and maintenance of symbiosis, and emphasizes the effects of symbiosis as a process on ecological communities and the evolution of organisms.

In the preface, the author explains that the book is motivated by three developments: (1) molecular and genetic techniques that have permitted the investigation of symbiosis at a level not previously possible; (2) a conceptual shift from symbiosis as a reciprocal exchange of benefits to one in which a controlling partner manages conflict between symbionts; and (3) increasing recognition of applied importance of symbiosis for environmental, agricultural, and human health. *The Symbiotic Habit* weaves these three themes into a narrative that integrates case studies from a broad range of taxa and ecosystems with general concepts that transcend individual taxa or habitats. Although Douglas's specialty may be insects, she draws key examples from a variety of taxa and ecosystems—she presents a more than ample discussion of symbioses involving plant, microbial, and marine taxa to reinforce the broad importance of symbiosis for life

on Earth and to keep the interest of the general reader. Overall, I found the book readable and quite insightful.

Douglas notes that a vexing aspect of the study of symbiosis is the many ways the term is defined and the topic delineated by different scientists. She works through this issue in an early chapter, explaining the lack of a universally agreed upon definition yet not dwelling on what might be an esoteric topic for some readers. Given the breadth of the spectrum to which the principles of symbiosis most likely apply, one might wonder whether any restrictions from the general dictionary definition (she cites as “an association between different species from which all participating organisms benefit”) have much use. Regardless, Douglas makes it clear that by “symbiosis” she refers only to organisms that have significant direct physical contact, as the increased intimacy of such relationships implies a more closely intertwined fate that is not the case in looser associations. The author acknowledges, however, that a rigid definition based on a specific duration of contact is unrealistic, and she quite intentionally provides examples of mutualistic interactions that do not (by her definition) appear to be strict symbioses to illustrate general principles. I found this refreshing and a major strength of the book that increases its utility to a broad readership. What emerges is a common thread from many of the concepts that apply to symbioses between intimately associated organisms to ecological and evolutionary aspects of looser associations among free-living species.

That said, *The Symbiotic Habit* addresses phenomena unique to intimate symbioses such as those that are intracellular. As someone who is most familiar with interactions among macroscopic, free-living organisms, I nonetheless found fascinating the sections on genomic deterioration and assimilation of symbionts, including the limits to assimilation and speculation as to why some symbionts may never be fully assimilated. Even the

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detailed description of molecular signaling between rhizobia and legumes is engaging because Douglas clarifies the implications of such findings for understanding symbioses in general, discussing this work in the context of “partner choice” and “conflict management.” I would suspect that people more familiar with specific intimate symbioses would likewise find stimulating her discussion of examples of less intimately associated organisms and their relevance to general principles of symbiosis.

Indeed, this is the strength of the book: Through Douglas’s narrative, researchers interested in molecular-level interactions and signaling between organisms find common ground with ecosystem scientists. The fact that these examples are interwoven and not separated in discrete sections is key, making it impossible for even “skimmers” to miss the parallels. One such parallel lies in Douglas’s discussion of symbioses as an interacting community of symbiont species or genotypes within a single host (whether it’s multiple microbes in the gut of a vertebrate or organelles within a eukaryotic cell), rather than the pairwise interactions between a single host and symbiont. This mirrors recent studies of mutualisms among macroorganisms that move beyond pairwise mutualisms to multiple ant or fungal associates of a single host plant or even mutualistic networks among many host plants and their overlapping pollinators. In this discussion, Douglas makes predictions about the outcome of interactions involving multiple symbionts on the basis of the extent to which symbionts provide distinct versus overlapping benefits to the host, pulling examples from both intimate symbioses and loose associations among free-living organisms.

Overall, *The Symbiotic Habit* provides a detailed yet readable overview of many conceptual issues surrounding symbiosis, and the range of examples also illustrate the importance of the topic to most biologists. Although Douglas provides plenty of examples and rich detail, she wisely

avoids attempting to write a comprehensive volume, rendering the book fewer than 200 pages of text and readable from cover to cover.

Douglas writes in her closing chapter that the breadth of symbioses studied gives strength to symbiosis as a discipline; she clearly demonstrates this with the phylogenetic and habitat diversity of the book’s examples. In her words, symbiosis is “not simply a type of interaction in the continuum of benefit and harm. It is a first-order process in the evolutionary diversification of living organisms, a crucial element to physiological function of most eukaryotes, and a major determinant of the structure of ecological communities.” In *The Symbiotic Habit*, the reader will find an authoritative glimpse into the fascinating world of symbiosis and the concepts that are emerging from recent advances.

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MEASURING UP THE DEEP

Deep-sea Biodiversity: Pattern and Scale. Michael A. Rex and Ron J. Etter. Harvard University Press, 2010. 368 pp., illus. \$55.00 (ISBN 9780674036079 cloth).

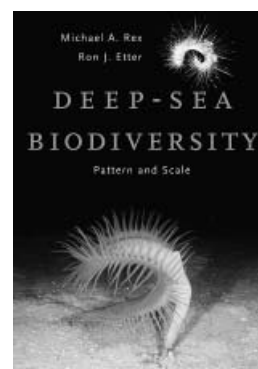
No scientist could challenge the assertion that Earth is the most biodiverse planet in the solar system. Few would challenge that lower-latitude ecosystems are more biodiverse than higher-latitude ones. But in this game of “biodiversity trumps” there are some closer calls. In the early 1990s, Fred Grassle and others challenged the ecological community with an assertion that the deep sea—cold, dark, and still fairly poorly sampled—could rival or exceed tropical rainforests and coral reefs for biodiversity. It was an

astounding claim, and although the authors were careful to qualify it, they were widely criticized for the daring of their extrapolations. Nevertheless, high deep-sea diversity is now an established paradigm, and the excellent new book *Deep-sea Biodiversity: Pattern and Scale*, by Michael A. Rex and Ron J. Etter, provides a veritable barrage of data-missiles to hurl at any terrestrial-based doubters.

Those scientific missiles are not hurled by these authors, however. Indeed, this is a calm, analytical, and elegantly written book that leads the reader neatly through the most important studies in deep-sea ecology. It may feel like a book in the hand, but it reads like a polished review paper; the prose is wonderfully clear and concise. There are no flights of fancy, complex analogies, or firsthand accounts of derring-do on the high seas. There is just the data, the analyses, and the ideas of two highly respected researchers in the field.

The book, as befits its subtitle, is organized around the concepts of pattern and scale. It starts with a review of quantitative data on abundance and food supply, building then through chapters on local diversity, regional diversity, beta diversity, and finally the evolutionary origins of deep-sea biodiversity. Processes are invoked throughout, and the final chapter aims—and partially succeeds—at a challenging synthesis.

The chapters that discuss broader, macroecological trends in deep-sea biodiversity are the highlights; they build on several papers by the authors themselves



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