explain his points; and, in addition, he always clarifies how far the data should be pushed and makes notes about facts that are important in interpreting the data. In Chapter 2, for example, Jeffrey identifies how data on the lack of underground parts and on fluxes of elements are needed when using tissue nutrient concentrations as a diagnostic tool for detecting plant nutrient deficiencies.

This book should be used by readers who already have some understanding of plant-soil interactions but wish to have a fresh perspective or develop new hypotheses. It is not one for a novice in the field.—*Kriistina Vogt, Forestry and Environmental Studies, Yale University*

Symbiogenesis: A Macro-Mechanism of Evolution. Werner Schwemmler. 226 pp. Walter de Gruyter and Co., 1989. $75.

Contemporary science seems to foster specialization. Even those areas of inquiry, such as evolutionary biology, that have historically rewarded scientists for having a broad view of their discipline are today increasingly populated by workers who have specialized interests. Within this context, it is refreshing to encounter an author who attempts to put all the specifics of a diversified phenomenon such as evolution together into a unified whole. Werner Schwemmler's recent book, *Symbiogenesis: A Macro-Mechanism of Evolution*, is, as its subtitle indicates, an effort "towards a unified theory of evolution."

In his introductory chapter Schwemmler provides a very brief overview of what he sees as the major philosophical issues underlying the development of a unified evolutionary theory. This is followed by a generally excellent and concise summary of the current views on cosmogenesis, chemogenesis and biogenesis; that is to say, of the steps involved in the evolutionary transition from inorganic matter to living cells. Unfortunately, the author then changes his stance from that of an objective critic of the relevant work of others into a somewhat less objective advocate as he presents his own views on the evolution of these complex systems. Although there is nothing wrong with trying to market your own views, in this instance I was left with the impression that too many sweeping ideas were being advanced too quickly with too little factual support.

The heart of Schwemmler's theory rests on what he sees as three principles of macroevolution. The "phase principle" states that the evolution of new "phases," or stages of evolutionary complexity, occur in "leaps" and cannot, in general, be accounted for by those classical Darwinian mutation or selection models that are adequate for explaining more gradual evolutionary transitions. The mechanism by which such evolutionary leaps are achieved is, according to Schwemmler, the integration of variants found on the next-lower-level of complexity (the "modular principle"). Schwemmler uses the term "integration" quite literally, as in the view that eucaryotic cells are a composite created by the integration of more primitive cell types. While this principle seems to appropriately describe what has taken place over the course of cellular evolution, Schwemmler would have us believe that the same principle can be applied to the evolution of complexity on all levels. ("Thus, atoms arose from various particles... procytes from various precytes... and plants and animals from different eucytes.") To support his opinion, Schwemmler offers his "periodicity principle," in which he points out the compartmental nature of increasingly complex systems (starting with the subatomic world and ending on the level of human culture).

Although I found the first half of the book to be interesting and informative, the arguments presented in the second half seem rather unconvincing. The notion that more complex organisms have evolved from organisms belonging to "the next lower level" of complexity does not seem to me especially novel. More important, speculation and analysis about the mechanisms that might underlie the emergence of new complexities is not satisfactorily discussed.

Although Schwemmler makes it clear that he views symbiogenesis as the process that underlies the emergence of complexity in evolution, the precise mechanisms by which this process acts are obscure except when he relates them to cellular evolution. The application of his "theory" to biological complexity would have been more interesting, from my perspective, if Schwemmler had discussed it within the context of genomic evolution. For example, he might have explored the question of whether more complex phenotypes could be generated by merely altering the timing or the tissue-specific pattern of pre-existing genes (that is, altering the relationship between pre-existing units of complexity) or whether new genes are required before more complex systems can evolve. He might have asked if the "integration" of new units into a system is a prerequisite for the emergence of higher complexity. As it stands, Schwemmler's treatment of developmental biology and genetics is superficial and dated. Although I am not an expert on the evolution of human culture, Schwemmler's explanation of this process also seems simplistic and lacking in detail.

In general, Schwemmler has done a commendable job in pointing out some interesting and apparently recurrent trends in the evolution of complexity. However, it is still very much an open question as to whether these apparent trends are in fact a manifestation of a single common process (such as symbiogenesis).—*John F. McDonald, Genetics, University of Georgia*

Ecology of Reptiles. Harold Heatwole and Janet Taylor. 325 pp. Surrey Beatty & Sons, 1987. $36.90.

The Age of Reptiles is said to have ended 65 million years ago with the extinction of dinosaurs and their kin and the rise of the mammals. Herpetologists know otherwise: there are about twice as many species of reptiles alive today as there are mammals, and in some habitats reptiles outnumber all other vertebrates. Because of their taxonomic and ecological diversity (and perhaps because of their inherently aesthetic appearance) they have served as important models in studies of evolutionary ecology, behavior and physiological ecology.

We thus live in an age of reptiles, but until now students and nonprofessionals who sought a general, technical but readable work on reptilian natural history would have been hard-pressed to find one. *Ecology of Reptiles* offers to remedy this situation. The title belies the more general scope of the work, which discusses ecology from the individual to the community level, biogeography, behavior and physiology. The authors did their research in Australia, and therefore most examples are from that environment. American readers need not suffer, however, because the emphasis is on concepts rather than on local taxa. Several color pages present some of the more photogenic Australian species. Students will benefit from the accessible prose; their senior colleagues should enjoy being reminded of just how much good biology has been done on reptiles.

There are, however, a few criticisms to be made of the text. Although the volume's scope is large, emphasis by subject is sometimes quirky and often dated. Body temperature receives the most attention (75 pages, including 18 pages of tables of mostly empty elements), but diet and foraging get only eight pages, and social behavior a tiny seven. Similarly, important topics of current interest, including sex-determination mechanisms, effects of parasites, evolutionary physiological ecology, ecological genetics and sexual selection, are almost ignored. Parthenogenesis is covered by a few lines with a 1962 reference—not the way for a beginner to enter this large and vital area of research.—*Joseph J. Schall, Zoology, University of Vermont*

The Emergence of Animals: The Cambrian Breakthrough. Mark A. S. and Dianna L. Schulte McMenamin. 217 pp. Columbia University Press, 1990. $18.

In all the history of life on earth, only the story of its origins and that of the evolution of humanity can be compared