deed Nicolis himself remarks that "macroscopic order is sandwiched between equilibrium thermal disorder and turbulent disorder." It is likely that very special conditions are required to obtain biological order from physical chaos. A paper by P. Schuster describes recent investigations by Eigen, Schuster, and others along such lines on the origin of the genetic code. The key idea, that self-replicating macromolecules must cooperate rather than compete to develop more organization, seems very plausible. There is also an excellent review by S. A. Kauffman of the topic of pattern formation in developing organisms, one highlight of which has been the formulation of rules for the regeneration of limbs and the like by French, Bryant, and Bryant and another the application of Turing's theory of pattern formation in diffusion-coupled chemical reactions to development and regeneration. The Turing theory gives a plausible account of such processes, but once again the stability exhibited by living tissues seems to be considerably greater than that exhibited by simple chemistry.

The book contains a number of papers concerned with solitons, fluid dynamics, and plasmas and with nonlinear equations in general. There is a very useful paper on the numerical computation of nonlinear waves by B. Fornberg, for example, in which many different numerical algorithms are discussed. Nevertheless it is fair to state that applications to biological problems dominate the volume, so that it will be of most interest to mathematical biologists. The volume itself is well produced. There are almost no errors in the text, and the format makes it easy to read.

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Desert Biology

Biology of Desert Invertebrates. CLIFFORD S. CRAWFORD. Springer-Verlag, New York, 1981. xvi, 314 pp., illus. $39.30.

Deserts are hot, dusty, generally uncomfortable places to be, and biologists working in them must have surely wondered at times about the cost-benefit ratio involved in extracting information about desert life.

Yet deserts have a diverse biota that, living under conditions that are often very stressful, provides an excellent opportunity for studying how plants and animals adapt to ecological constraints. Such constraints may be seen in the physiology, behavior, life history, and community assemblages of desert organisms. Often the constraints may be expressed as ecological convergence in form and function, as is seen among the cacti of North America and the cactus-like euphorbs of the Old World.

Among desert organisms, the most numerous are the invertebrates. Commonly found in deserts are protozoans, nematodes, mollusks, arachnids, millipedes, centipedes, and a variety of insects. Many of these have a great impact on desert life. For example, termites in the Sonoran desert can consume over 90 percent of the dead wood that falls in one year.

Despite their importance to the dynamics of desert systems, finding information on the ecological, behavioral, and physiological roles of desert invertebrates has been difficult. A number of excellent studies of single species, or even groups of species, have been published in diverse journals, but the information has been difficult to piece together.

Crawford has made a major contribution toward our understanding of desert invertebrates by arranging the details into patterns. Without sacrificing the particulars, he has assembled information from many sources and organized it around the themes of behavioral and physiological adaptations, life history adaptations, and community roles.

Crawford has done an excellent job of putting things together, and perhaps just because of that I found myself wishing for somewhat more synthesis. There are questions that touch on some important concepts in ecology that are not addressed in the book. For example, how are communities of desert invertebrates structured—randomly, by competition, by predation, or by historical constraints? What is the role, if any, of competition in a stressful environment? In a harsh environment, how much leeway does selection have in affecting the physiology and behavior of an animal without colliding with phylogenetic inertia?

Crawford's book nevertheless represents an excellent start. Now that we have the particulars organized into comprehensible patterns, we can ask broader questions that before could not be asked intelligently.

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Bioenergetics

Chemiosmotic Proton Circuits in Biological Membranes. In Honor of Peter Mitchell. V. P. SKULACHEV and PETER C. HINKLE, Eds. Addison-Wesley Advanced Book Program, Reading, Mass., 1981. xviii, 634 pp., illus. $29.50.

This book consists of 39 papers covering a wide variety of topics in bioenergetics. The unifying theme connecting topics as seemingly disparate as oxidative phosphorylation, proton transport in the stomach, photosynthetic electron flow, catecholamine storage in the adrenal medulla, and the mechanism of flagellar motion and bacterial active transport is the central role of the electrochemical proton gradient ($\Delta\tilde{\mu}_{H^+}$) in all these processes. Thus the book clearly fulfills its stated aim of honoring Peter Mitchell on his 60th birthday. For it was Mitchell who, some two decades ago, almost single-handedly focused the attention of workers in bioenergetics on the central role of the electrochemical proton gradient in biological energy coupling. As Racker, in the introduction to his paper, aptly says, "his conceptual contributions . . . have revolutionized our thinking as well as our experimental approaches." The level of the book is too advanced and in some papers too specialized to serve as a first introduction to this revolution. However, a moderately well informed reader will find the book provides a nice overview of the effects of these revolutionized approaches.

The book opens with an excellent introductory paper by one of the editors, Skulachev, outlining the central concepts of Mitchell's chemiosmotic hypothesis, the history of its grudging acceptance by the bioenergetics community, and the subjects of chief current concern to workers in the field. The review, although brief, will be of particular interest to those of my generation who as graduate students or young postdocs saw the chemiosmotic hypothesis greeted with something close to ridicule in the early 1960's and watched as acceptance of Mitchell's ideas culminated with the award of the Nobel Prize in Chemistry in 1978. Skulachev also succeeds in giving the reader a good feeling for the wide variety of biological energy transducing systems that have been successfully analyzed by means of the chemiosmotic hypothesis.

Next there are 21 papers describing systems the editors have described as "$\Delta\tilde{\mu}_{H^+}$ generators." Two highlights of this section of the book are a fair discus-