however, instructors may wish to provide supplemental readings that represent a broader variety of trophic levels and taxonomic categories and to distinguish more clearly than the authors do between physiological and evolutionary adaptation.

Biochemical Adaptation is very well organized. It begins with an overview of the basic mechanisms and strategies of cellular and biochemical adaptation. After laying the metabolic groundwork, the book traverses such diverse topics as enzyme adaptation, anoxia, hypoxia, diving adaptation, anhydrobiosis, hibernation, water-solute problems, oxygen transport, and pressure effects. Several special topics are addressed that the authors think deserve particular attention in light of the extent of recent research or the potential for future research. Though all 12 chapters are well written and illustrated, those on exercise adaptation, limiting oxygen availability, mammalian developmental adaptations, temperature adaptation, and adaptation to the deep sea are particularly interesting.

The chapter on temperature adaptation presents a particularly thought-provoking treatment of protein adaptations, including thermally induced adjustments of enzyme catalytic efficiencies, differential interspecific compensation of the partitioning of free-energy terms ($\Delta G^{\ddagger}$, $\Delta H^{\ddagger}$, and $\Delta S^{\ddagger}$), interspecies conservation of Michaelis-Menten constants, temperature adaptations of allelic isozymes, and thermal effects on both enzyme concentrations and protein subunit assembly. The authors introduce "compensation plots" ($\Delta H^{\ddagger}$ versus $\Delta S^{\ddagger}$) for homologous enzymes from a series of evolutionarily divergent species. Since these plots are empirically found to be linear for a variety of enzyme reactions and $\Delta G^{\ddagger} = \Delta H^{\ddagger} - T\Delta S^{\ddagger}$, it follows that $\Delta G^{\ddagger}$ for a given enzyme reaction must be relatively invariant, whereas the partitioning of energy between $\Delta H^{\ddagger}$ and $\Delta S^{\ddagger}$ varies tremendously among species. The possible evolutionary significance of this and related phenomena is of course fascinating. The apparent evolutionary constraints on $\Delta G^{\ddagger}$ may appear to be contrary to the authors' assertion that "the critical energy change is always $\Delta G^{\ddagger}$." However, since free energy of activation is exponentially related to catalytic rate, even very small differences in $\Delta G^{\ddagger}$ could have profound effects on rate constants.

The last chapter of the book, which deals with the role of pressure, should capture the imagination of even the most jaded reader. Students may be conceptually prepared to consider the influences of temperature on enzyme catalysis, protein conformation, and polymerization, but the effects of pressure on these processes may be somewhat foreign to even the most sophisticated. The authors do an admirable job in introducing the subject, calling upon appropriate literature to illustrate the phenomena. This chapter finishes with some of the adaptations of diverse organisms living near the deep-ocean hydrothermal vents, which were discovered only a few years ago. It leaves the reader with the expectation that the most exciting research and discoveries on vent organisms are yet to come.

The general conclusion to which one is led by the book is that organisms possess elegant biochemical adaptations that allow them to flourish in a myriad of diverse environments. Though these often include unique and even bizarre modes of adaptation, they are but "variations on a fundamental theme." Understanding the detailed mechanisms of such adaptations and the rationale for the various adaptive strategies will help unlock the secrets of speciation, habitat partitioning, and the driving forces of evolution.

DENNIS POWERS
Department of Biology,
Johns Hopkins University,
Baltimore, Maryland 21218

Plants and Herbivores

Herbivory. The Dynamics of Animal-Plant Interactions. MICHAEL J. CRAWLEY. University of California Press, Berkeley, 1983. $45. Studies in Ecology, vol. 10.

One goal of ecology is to decipher the principles that determine the distribution and abundance of organisms in nature and how those features change over time. The major impediment to realizing this goal is the fact that the distribution and abundance of a particular species are influenced by the other species with which it interacts. Since most species interact with many others, specifying how the web of interactions influences the population dynamics of a given species becomes an exceedingly complex task.

The volume by Crawley exemplifies one approach to that task and illustrates admirably both the complexity inherent in interspecific interactions and a general methodology one may adopt for understanding it. The author begins by pointing out that much is known about how herbivory can influence plant growth rates, mortality, reproductive output, and competitive ability and about how plant density and physiological state can influence herbivore growth, mortality, and reproduction. The key word here is "can." Crawley's exhaustive review of these effects in the second and third chapters quickly convinces one that there is no universal effect of herbivores on plants or vice versa. In some plant species, massive defoliation reduces seed set, in others it does not. In some it increases mortality, in others it does not. The feeding rates of some insect species increase in response to changes in foliage quality, those of others decrease, and those of still others are not affected. The populations of some herbivores (for example snowshoe hares and *Cactoblastis* moths) seem to be limited in size by availability of food, whereas those of others (for example the *Opuntia*-feeding cochineal *Dactylopius opuntiae* and the spruce budworm) seem to be regulated by predators and parasites. This variety of interactive effects should surprise no one in the field, but nowhere is it so carefully and thoroughly documented as here.

Crawley's survey could lead one to conclude that there are no general principles governing plant-herbivore population dynamics and that a quantitative description of the population dynamics of any plant-herbivore system requires a unique model tailored to the unique attributes of that system. Indeed, such an approach is common among agricultural entomologists, who must predict very precisely the population sizes of pest species in order to predict levels of crop damage and optimal times for application of pesticides. However, Crawley's method of modeling plant-herbivore population dynamics illustrates that an alternative approach not only is possible but may in fact reveal principles not apparent from other approaches.

Crawley uses what may be termed the "modular" approach to modeling plant-herbivore dynamics, which should be familiar to ecologists as that adopted by M. P. Hassell and his colleagues for modeling predator-prey dynamics. The rate of change of each species is represented as the difference between birth and death rates, which in turn can be represented by a variety of different submodels or "modules." For example, one may use for plant birth rate a submodel that assumes that fecundity is independent of density, one that assumes that it is density-dependent in a fashion described by the traditional logistic equation, or one that includes parameters that represent effects of impaired plant growth due to defoliation. Similarly, for herbivore birth rate one may use submodels that assume that fecundity is governed by any one of three commonly recognized types of functional response or one that assumes that it is not linearly related to food input. One simply decides which of these submodels best describes the birth and death processes of a system, plugs it into the basic difference or differential equations that constitute the model, and determines the equilibria and their stability by standard mathematical techniques.

This approach preserves a high amount of generality because all models are constructed from a small number of basic submodels; yet, because the submodels can be combined in many ways, it permits description of the many kinds of dynamical patterns exhibited by diverse plant-herbivore systems. Moreover, it allows one to explore how plant-herbivore dynamics might be affected by differences in the conditions assumed in alternative submodels. For example, the effects of plant compensation—the ability of a plant to minimize or eliminate adverse effects of low levels of herbivory—can be described by assuming that the relationship between mortality and death rate is nonlinear rather than linear. By substituting a submodel of plant death rate that assumes a nonlinear relationship for one that assumes a linear relationship, one can demonstrate that equilibrium herbivore populations are expected to increase and become more stable. It is doubtful whether this type of insight about the effects of a general process like plant compensation could be as easily derived from a unique model developed for a specific plant-herbivore system.

Of course, no approach to modeling is without pitfalls. Crawley himself cautions that the models he develops are descriptive and not explanatory, that "the fact that a model shows the same pattern as the data is no indication that the structure of the model matches the structure of the real plant-herbivore system." These models do, however, help investigators explore the ramifications of assumptions about population dynamics that they are forced to make. As the author states, "Unless we know the consequences of simple assumptions about plant-animal interactions, we are in no position to interpret the complex data we obtain from the field, where interaction effects are compounded by genetic, climatic, and spatial variability."

This volume belongs on the shelf of any biologist seriously interested in the population dynamics of plants or herbivores. As a compendium of information on the ecological interactions between these two groups of organisms it is unsurpassed. Students entering the field and experienced researchers looking for new approaches to plant-herbivore interactions will find the book highly stimulating. One cautionary note should be sounded, however. One could be stimulated by this book to rush out and attempt to find an appropriate plant-herbivore system for testing some of the hypotheses and generalizations put forward by Crawley in his last chapter. In doing so, one would be assuming implicitly that the interaction between the two species is the dominant effect on the population dynamics of each. If one found this not to be the case, as must often be true, one would be left with very little positive to say about what regulates the dynamics of either the plant or the herbivore. In my opinion, a more productive approach is to begin by concentrating on a single species and examining all factors (including food resources, competitors, predators, and genetic constraints) that could be controlling its numbers. Only if one is then led to the conclusion that herbivores (for a plant) or food availability (for a herbivore) is indeed the dominant influence on numbers should one adopt Crawley's or some similar framework as a guide to further experimentation. If one is not led to this conclusion, however, one is in a much better position to know to which other paradigm to turn for further guidance.

MARK D. RAUSHER
Department of Zoology,
Duke University,
Durham, North Carolina 27706

Books Received

Acoustical Imaging. Vol. 13. M. Kaveh, R. K. Mueller, and J. F. Greenleaf, Eds. Plenum, New York, 1984. xii, 605 pp., illus. $89.50. From a symposium, Minneapolis, Oct. 1983.

Adaptive Systems in Control and Signal Processing 1983. I. D. Landau, M. Tomizuka, and D. M. Auslander, Eds. Published for the International Federation of Automatic Control by Pergamon, New York, 1984. xii, 376 pp., illus. $94. From a workshop, San Francisco, June 1983.

Advances in Cryogenic Engineering. Vol. 30, Materials. A. F. Clark and R. P. Reed, Eds. Plenum, New York, 1984. xxii, 998 pp., illus. $95. From a conference, Colorado Springs, Colo., Aug. 1983.

Advances in Plant Nutrition. Vol. 1. P. B. Tinker and André Läuchli, Eds. Praeger, New York, 1984. xviii, 301 pp., illus. $32.95.

Ascochyta Blight and Winter Sowing of Chickpeas. M. C. Saxena and K. B. Singh, Eds. Nijhoff/Junk, The Hague, 1984 (U.S. distributor, Kluwer Boston, Hingham, Mass.). xii, 288 pp., illus. $57.50. World Crops, vol. 9. From a workshop, Aleppo, Syria, May 1981.

Astronautics and Aeronautics, 1976. A Chronology. Eleanor H. Ritchie. NASA Scientific and Technical Information Branch, Washington, D.C., 1984. 397 pp., illus. Paper, $9.50. The NASA History Series. NASA SP-4021.

Astronomy with Schmidt-Type Telescopes. Massimo Capaccioli, Ed. Reidel, Boston, 1984 (distributor, Kluwer Boston, Hingham, Mass.). xxii, 619 pp., illus. $84. Astrophysics and Space Science Library, vol. 110. From a colloquium, Asiago, Italy, Aug. 1983.

Atlas of Skin Repair. János Zoltán. Karger, Basel, 1984. 303 pp. $96. Translated from the German edition by Klára Takácsi-Nagy.

Automation in Mining, Mineral and Metal Processing 1983. T. Westerlund, Ed. Published for the International Federation of Automatic Control by Pergamon, New York, 1984. xviii, 754 pp., illus. $185. IFAC Proceedings Series. From a symposium, Helsinki, Aug. 1983.

Aven Nelson of Wyoming. Roger L. Williams. Colorado Associated University Press, Boulder, 1984. xii, 407 pp., illus. $29.50.

Bats. A Natural History. John E. Hill and James D. Smith. Published in co-operation with the British Museum (Natural History) by University of Texas Press, Austin, 1984. iv, 243 pp., illus. $24.95.

Becoming William James. Howard M. Feinstein. Cornell University Press, Ithaca, N.Y., 1984. 377 pp., illus. $24.95.

Being Alive on Land. N. S. Margaris, M. Arianoustou-Faraggitaki, and W. C. Oechel, Eds. Junk, The Hague, 1984 (U.S. distributor, Kluwer Boston, Hingham, Mass.). x, 322 pp., illus. $72. Tasks for Vegetation Science 13. From a symposium, Halkidiki, Greece, Sept. 1982.

Changing Agricultural Production Systems and the Fate of Agricultural Chemicals. George W. Irving, Jr., Ed. Agricultural Research Institute, Bethesda, Med., 1984. 160 pp., illus. Paper, $7.50. From a conference, Chevy Chase, Md., Feb. 1984.

Chemical Regulation of Immunity in Veterinary Medicine. Meir Kende, Joseph Gainer, and Michael Chirigos, Eds. Liss, New York, 1984. xvi, 604 pp., illus. $88. Progress in Clinical and Biological Research, vol. 161. From a symposium, Bethesda, Md., Sept. 1983.

Development of Visual Pathways in Mammals. Jonathan Stone, Bogdan Dreher, and David H. Rapaport, Eds. Liss, New York, 1984. xvi, 489 pp., illus. $68. Neurology and Neurobiology, vol. 9. From a symposium, Sydney, Aug. 1983.

Developments and Applications of Geomorphology. John E. Costa and P. Jay Fleisher, Eds. Springer-Verlag, New York, 1984. xiv, 372 pp., illus. $44.

Emergent Process Methods for High-Technology Ceramics. Robert F. Davis, Hayne Palmour III, and Richard L. Porter, Eds. Plenum, New York, 1984. xvi, 842 pp., illus. $95. Materials Science Research, vol. 17. From a conference, Raleigh, N.C., Nov. 1982.

The Encyclopedia of Applied Geology. Charles W. Finkl, Jnr. Van Nostrand Reinhold, New York, 1984. xxviii, 644 pp., illus. $75. Encyclopedia of Earth Sciences Series, vol. 13.

Energy and the Environment. John M. Fowler. 2nd ed. McGraw-Hill, New York, 1984. xvi, 655 pp., illus. Paper, $22.95.

Environmental Warfare. A Technical, Legal and Policy Appraisal. Arthur H. Westing, Ed. Stockholm International Peace Research Institute, Stockholm, and Taylor and Francis, Philadelphia, 1984. xiv, 107 pp. Paper, $27. From a symposium, Geneva, April 1984.

Equations of Membrane Biophysics. N. Lakshminarayanaiah. Academic Press, Orlando, Fla., 1984. x, 426 pp., illus. $69.

Essential Reproduction. Martin H. Johnson and Barry J. Everitt. 2nd ed. Blackwell Scientific, Palo Alto, Calif., 1984. x, 367 pp., illus. Paper, $19.50.

Essential Systems Analysis. Stephen M. McMenamin and John F. Palmer. Yourdon, New York, 1984. xvi, 392 pp., illus. Paper, $28.

Evaluation of Occupational and Environmental Exposures to Radon and Radon Daughters in the United States. Recommendations of the National Council on Radiation Protection and Measurements. National Council on Radiation Protection and Measurements, Bethesda, Md., 1984. x, 204 pp. Paper, $15. NCRP Report 78.

Exploring the Universe. W. M. Protheroe, E. R. Capriotti, and G. H. Newsom. 2rd ed. Merrill (Bell and Howell), Columbus, Ohio, 1984. xvi, 586 pp., illus., + plates. Cloth.

Flight in America, 1900–1983. From the Wrights to the Astronauts. Roger E. Bilstein. Johns Hopkins University Press, Baltimore, 1984. xii, 356 pp., illus. $32.50; through 31 Mar. 1985, $27.50.

Food and Energy Resources. David Pimentel and Carl W. Hall, Eds. Academic Press, Orlando, Fla., 1984. xvi, 270 pp., illus. $47.50. Food Science and Technology.

Forces of Production. A Social History of Industrial Automation. David F. Noble. Knopf, New York, 1984. xviii, 409 pp. + plates. $22.95.

The Formation of Craft Labor Markets. Robert Max Jackson. Academic Press, Orlando, Fla., 1984. xviii, 355 pp. $45. Studies in Social Discontinuity.

Geologic Principles for Prudent Land Use. A Deci-

(Continued on page 870)