BOOK REVIEWS

Engines of Biodiversity

Plants in Changing Environments. Linking Physiological, Population, and Community Ecology. F. A. BAZZAZ. Cambridge University Press, New York, 1996. x, 320 pp., illus. $75 or £55, ISBN 0-521-39190-3; paper, $29.95 or £19.95, ISBN 0-521-39843-6.

Ambrosia versus *Abutilon*. *Erigeron* versus *Solidago*. *Polygonum* versus *Setaria*. Which plants will win in competition, and how will plant communities express the victories and losses? When Kasparov faces Deep Blue, each brings to the chessboard a vast archive of strategies, deceptions, and techniques for dealing with novel situations. But are the stratagems of the grand master more intricate or multidimensional than the interactions between the plants of abandoned agricultural fields? In *Plants in Changing Environments* Fakhri A. Bazzaz explores the nature of plant-plant interactions, documenting a richness that could be the envy of a grand master.

Succession, the sequence of changes in an ecosystem following disturbance, is one of the oldest and most discussed topics in plant ecology. From early debates, which often focused on the relative importance of individual species versus emergent properties of whole ecosystems, to recent models on the requirements for species coexistence, succession has integrated many of the big questions in plant ecology. Now, increases in disturbances generated by humans place a new priority on understanding the consequences and mechanisms of succession. Whether disturbance is generated by a natural process, like a fire or a hurricane, or by an anthropogenic process, like deforestation, nutrient deposition, or climate change, succession following disturbance is characterized by a number of common themes, including features of the plants that are most successful at different stages.

Plants in Changing Environments explores common themes, as well as irregularities, in plant succession, drawing especially on results of multidisciplinary studies by Bazzaz and his colleagues over the past 20 years. By focusing on a few well-studied examples, Bazzaz is able to link observations across fields and evaluate the relative roles of dramatically different processes, such as seed germination requirements, biomass allocation, and photosynthetic responses, in controlling ecological success. The examples from studies by the Bazzaz group on abandoned fields in Illinois, mixed deciduous forest in Massachusetts, and tropical rainforest in Mexico and Southeast Asia span a broad range of ecosystems and patterns of succession. They also represent a very substantial fraction of the multidisciplinary studies on plant succession. Bazzaz and his students were early advocates of the idea of linking studies on physiological controls on ecological responses, genetic variation within populations, and consequences of these for the composition of the plant community. Their dedication to this multidisciplinary approach and their persistence in applying it to a small number of ecological settings have resulted in a truly unique body of information.

The book is organized around understanding the process of plant succession, but succession is the framework for an even more important discussion. At its core, *Plants in Changing Environments* is about the natural mechanisms that regulate biodiversity. Bazzaz details a fantastic diversity of ecological responses that allow different species to compete effectively for the resources they need to grow and reproduce. In most successions, any of a number of species can be dominants at some stage, and the regulators of success are often very different among species. In some cases, the date of disturbance, because it implies temperature during the season of seed germination, is the critical controller on relative dominance. In others, it is the level of drought, or high light, or time of the day at which plants are exposed to sunflecks. Some species recruit individuals for specialized habitats from populations with a large diversity of genotypes, while others achieve comparable flexibility with fewer, more variable genotypes.

Plants in Changing Environments does not develop a comprehensive model for predicting the trajectory of plant succession, though it makes a number of generalizations, including some that are quite strong. The book's central message, cemented with a plethora of examples, is that the mechanisms that control ecological success are diverse, complex, and multidimensional. Interactions among individuals and interactions between individuals and the environment have the richness and power to be engines maintaining biodiversity, if human actions allow the persistence of the species and genotypes that are the key players. *Plants in Changing Environments* is a window into the way those engines work.

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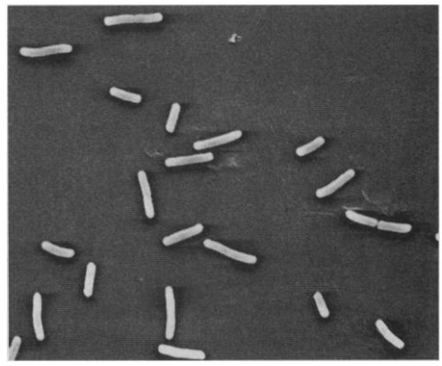
Microbial Invention

Regulation of Gene Expression in *Escherichia coli*. E. C. C. LIN and A. SIMON LYNCH, Eds. Chapman and Hall, New York, and Landes, Austin, TX, 1996. xvi, 592 pp., illus. $99.95 or £59. ISBN 0-412-10291-9.

Did *Escherichia coli* invent gene regulation? The casual browser might come to that conclusion from the prevalence of *E. coli* gene regulation in the biological literature of the past 50 years. The hyperbole in the question should not obscure the fact that an affirmative answer is closer to the mark than if the question were to be asked about any plant or animal, for *E. coli* is closer to the pre-prokaryotes in which gene regulatory mechanisms first developed in rich abundance. There are more proximate reasons, however, for the preoccupation of bacteriologists with gene regulation. The bacterial growth strategy involves rapid adjustments in the rate of expression of individual genes in response to second-by-second sensing of the environment. Other means of controlling cellular functions are used and are important, but it is the short half-life of their messenger RNA molecules and the physical linking of translation and transcription that enable modulation of gene function to be such a prominent fea-



Escherichia coli. [Courtesy of James T. Park]

ture of the physiology of bacterial cells.

Bacterial physiologists and molecular biologists alike have focused their attention on gene regulation for decades. The amount of knowledge gained has been staggering in its detail. This volume edited by Lin and Lynch summarizes some of the most significant recent work on this subject. Like other summaries of the subject, this volume, even as a multi-authored work, can only tell a sampling of stories, so prodigious is the amount of detail now available.

The book is grand. Its contents are consistent with the goal of the editors to provide an up-to-date presentation of the field. Besides an introduction and one historical account, there are 25 chapters, of which eight deal with general mechanisms of gene expression and their control and two with the physiological processes of cell division and differentiation into stationary phase; the remaining 15 describe selected gene regulatory systems, chosen because they have achieved classic paradigmatic status or because they involve complex multigene systems getting much current attention. Some 50 authors have contributed. For the most part they have taken seriously their charge of producing personal essays, rich not only in recent findings but also in accounts of "elegant experimental strategies [and] individual research styles," to quote the editors.

Because the book is successful—a more than competent treatment of key subjects—one might fairly ask whether it provides a sense of where this field has been, where it is, and where it is going.

In this regard the book has two defining moments. One occurs in the preface, when the editors discuss the functional organization of *E. coli* genes into *regulons* and *modulons* and point to the complexity of the regulatory circuits that tie multiple genes together. The second occurs in the introductory chapter, when Jon Beckwith reminds the reader that the molecular genetics of gene expression in *E. coli* is historically and conceptually bound inextricably to bacterial physiology. Beckwith's chapter, "From physiology to DNA and back," provides an appropriate motif for the entire volume. Both the editors and Beckwith recognize the relationship of molecular biology to the cell physiology of *E. coli*. Lin and Lynch direct the reader to the need for continued exploration of the multigene systems that are clearly central to the organized accomplishment of such integrated functions as adaptation to anaerobic or aerobic life, response to chemical and physical stress, and entry into stationary phase. Beckwith highlights the triumphs of molecular analysis but points to a future in which broader information about physiological phenomena informs and guides molecular analysis.

On the other hand, the book is silent on a broader message to be gleaned from these studies. The very large number and variety of gene control mechanisms and the uniqueness of their deployment are what will surely make an impression on every reader not already familiar with bacterial molecular genetics. Few operons seem to be controlled in precisely the same way. (Though it is not evident in this book, which is restricted to *E. coli*, the puzzle is increased when one recognizes that equivalent operons in different bacterial species are regulated in different ways.) Why is this so? Are different regulatory solutions functionally equivalent, owing their origin to historic happenstance, or does each solution confer an optimal behavior on a given gene, with natural selection guiding the origin and development of the particular regulatory circuit? This has to be a core question in the physiology of gene expression. That it is not asked in this book is consistent with the advice followed by many molecular biologists—never voice a question in public that one cannot answer. This question cannot be answered by the commonly employed reductionist approaches of molecular genetics, metabolism, or physiology. The future of the field of regulation of gene expression must include integrative studies using modern techniques of systems analysis—modeling techniques that utilize knowledge from molecular genetics, from ecology, and from global monitoring of intact cells to test the sufficiency and completeness of our knowledge about gene regulation in context.

Nonetheless, the editors and authors can take much pride in this product of their labors. The intended audience of teachers, investigators, and advanced students should benefit from this fine contribution to the microbial biology literature.

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Browsings

Billions and Billions. Thoughts on Life and Death at the Brink of the Millennium. Carl Sagan. Random House, New York, 1997. xii, 244 pp., illus. $24. ISBN 0-679-41160-7.

Nineteen essays on astronomy, the environment, and other topics by the recently deceased astronomer/popularizer, including reflections on his own mortality and an epilogue by his widow, Ann Druyan, describing their meeting and his last days.

Escherichia coli. Mechanisms of Virulence. Max Sussman, Ed. Cambridge University Press, New York, 1997. xvi, 639 pp., illus. $100 or £65. ISBN 0-521-45361-5.

A collection of 21 chapters reviewing virulence mechanisms, such as capsules, fimbriae, and toxins, of the different types of *E. coli* that cause intestinal and extraintestinal disease in humans and animals.

Giant Molecules. Here, There, and Everywhere. Alexander Yu. Grosberg and Alexei R. Khokhlov. Academic Press, San Diego, 1997. xviii, 244 pp., illus., + CD-ROM. $39.95 or £ . ISBN 0-12-304130-9.

A revised version of a 1989 Russian work on polymer physics, presented with the hope that it will "interest anyone with general curiosity about the world" because the subject "is right at the crossroads of so very many paths of contemporary development and ardent interest."

How To Do Archaeology the Right Way. Barbara A. Purdy. University Press of Florida, Gainesville, 1997. xvi, 200 pp., illus. $29.95. ISBN 0-8130-1392-5.

An exposition for the general public of the materials and methods by which archaeologists "come close to repeopling the ancient landscapes," with an account of the author's own research area, Florida.

Leading Personalities in Statistical Sciences. From the Seventeenth Century to the Present. Norman L. Johnson and Samuel Kotz, Eds. Wiley-Interscience, New York, 1997. xxvi, 399 pp., illus. Paper, $49.95. ISBN 0-471-16381-3. Wiley Series in Probability and Mathematical Statistics.

Brief accounts of the life and work of over 100 statistical scientists, with a table of "milestone events" in the field and a statistical analysis of the leaders' lifelengths (which the editors conclude does not support the hypothesis that people tend to die shortly after a birthday).

Mutants of Maize. M. Gerald Neuffer, Edward H. Coe, and Susan R. Wessler. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, NY, 1997. xii, 468 pp., illus. $250, ISBN 0-87969-443-2; paper, $100, ISBN 0-87969-444-0.

A successor to a 1968 work of similar title, including genetic maps of the 10 chromosomes, 148 pages of color plates showing the mutants, a list of genes, accounts of over 40 cloned genes, and information on other relevant topics.

Why People Believe Weird Things. Pseudoscience, Superstition, and Other Confusions of Our Time. Michael Shermer. Freeman, New York, 1997. xiv, 306 pp., illus. $22.95. ISBN 0-7167-3090-1.

The editor of *Skeptic* magazine takes a critical look at claims regarding paranormal experiences and encounters with aliens, the Ayn Rand cult, accusations of witchcraft, attempts to establish a scientific basis for religion, creationism, Holocaust denial, and the concept of race.