factor analysis and other multivariate methods, he has a chapter on statistics and probability distributions of air-pollution measurements.

In summary, Seinfeld's book is the more appropriate as a textbook for courses on air pollution or atmospheric chemistry except for courses that focus mainly on gas-phase phenomena. Both books will be of value to researchers in atmospheric science.

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Clonal Organisms

Population Biology and Evolution of Clonal Organisms. JEREMY B. C. JACKSON, LEO W. BUSS, and ROBERT E. COOK, Eds. Yale University Press, New Haven, CT, 1986. xiv, 530 pp., illus. $60; paper, $30. Based on a symposium, New Haven, Feb. 1982.

Living organisms can be classified by their mode of reproduction and by their construction. *Clonal* organisms reproduce by some form of asexual replication such as budding, stolon formation, or parthenogenesis, whereas *aclonal* species reproduce solely by sexual means. The body of a *unitary* organism is a single physiologically integrated unit, whereas the body of a *modular* species is composed of an organically connected assemblage of similar repeated units, called leaves, zooids, or polyps in various taxa, each of which functions at least semi-independently of its neighbors. Modular organisms, all of which employ some form of clonal replication, constitute the majority of the biosphere, and clonal unitary species have evolved independently in several unrelated animal and plant lineages. It is therefore fair to regard clonal organisms as an ecologically important group.

Most of the major paradigms in the fields of population ecology and evolution, by contrast, concern species whose basic ecological and evolutionary unit is the sexually produced individual organism. Such species are aclonal and unitary. Clonal species differ from aclonal ones in so many ways that assimilating them into ecological and evolutionary thought will require major extensions in both mathematical theory and methods of field study. Many ideas about the ecology and evolution of clonal organisms have appeared in the literature in recent decades, but their emergence from many unrelated research efforts has diffused their impact. In this volume of 13 chapters by botanists, zoologists, morphologists, physiologists, paleontologists, and theorists, these scattered ideas have finally been organized into a coherent description of the population biology of clonal organisms. These papers provide not a finished synthesis but rather a series of tantalizing, partly solved problems, and to my mind the publication of this book marks the formal debut of the exciting field of clonal organism population biology.

The strongest chapters present highly creative reinterpretations and syntheses of extensively reviewed existing knowledge. Harper's introductory chapter clearly contrasts clonal and aclonal organisms, discusses the biological significance of genets and ramets, and extracts from the agricultural literature useful insights into the adaptive significance of clonality. Silander observes that, contrary to expectation, clonal plants exhibit high genetic diversity, and he discusses evolutionary mechanisms unique to clonal organisms that probably cause this pattern. Hughes and Cancino describe the occurrence of clonal and aclonal lifestyles throughout the entire animal kingdom and clearly separate adaptive advantages of clonal reproduction from those of modular construction. Jackson concludes from a close examination of aquatic animals that clonality is a widespread adaptation to life in stable, crowded environments. Buss painstakingly documents clonal replication at several suborganismal levels of organization, highlights implications for ecology and evolution of certain molecular and immunological advances, and convincingly portrays the individual organism as an idealized abstraction that only approximates the organically self-contained units of real biological species.

Other chapters contain penetrating insights concerning branching patterns and physiological integration of clones, the roles of predation and physical habitat disturbance in shaping the evolution of clonal organisms, the connection between clonality and the evolution of intimate mutualistic associations, and the evolutionary history of clonality in corals and in the entire plant kingdom. The book's weaknesses include a fairly high redundancy among chapters, excessive wordiness and murky thinking in certain chapters, and rather poor development of mathematical theory. This last problem is not the fault of the authors, for their contributions do represent the current state of the art of ecological modeling. Rather, the problem arises from the formidable challenge of creating, essentially from scratch, a whole new theory for a diverse and very complicated group of organisms. Perhaps these tentative early attempts will help inspire development of a versatile and robust mathematical theory with close enough resemblance to biological reality to be genuinely useful in field studies of nature.

The editors and authors of this volume deserve vigorous applause for bringing so important a subject to the attention of population biologists. Their efforts have provided exciting reading, especially for graduate students, because understanding the contrast between clonal and aclonal organisms helps broaden one's perspective of the basic principles that underlie population biology and evolution.

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