ference between universal, testable hypotheses and descriptive, inductive generalizations. Small mammal ecology is a battlefield between Baconian and Popperian science, and this book shows us both sides. The problem with the Baconian approach is that the central problems of ecology that we ought to address can get lost in a welter of interesting natural history.

Grant and Brown avoid the Baconian pitfall by reviewing competition in small mammal communities and posing some key questions to stimulate future work. Other reviews are less successful. The section on the use of resources by small mammals is a compendium of descriptive data, as is the section on the impact of small mammals on ecosystems. Ecologists have hoped that the natural history phase of gathering data on resource partitioning and energy flow would be followed by a blossoming of theory on resource subdivision in small mammal communities, but so far little has emerged to stimulate the theorists. Wunder tries to link the conceptual models of environmental physiology to small mammal reproduction and distribution, and he points out clearly the predicament of too many irrelevant metabolic data and too few data relevant to ecological hypotheses of energy partitioning.

One looks almost in vain through the informal discussions for the emergence of the young Turks of small mammal ecology. Have they been edited away or are they too shy to challenge the old guard? More questionable statements are made in the sections on physiological and behavioral responses and population regulation than anyone should tolerate, yet the discussion is minimal. Davis concludes that one need not consider genetic changes in populations in order to understand changes in birth and death rates. I hope that not all the participants agreed with this pre-Mendelian stance. Hayne's exhortations about replication and experimentation seem lost in these sections, which form the low point of the book. This is ironic because the study of small mammals has contributed more to ecological ideas about population regulation than it has to other areas of ecology. In his review Lidicker presents a multifactor conceptual model of population regulation through density-dependent factors that is simultaneously archaic and untestable. The density-dependent regulation model is the ecologist's phlogiston theory, useful years ago but now an obstruction to progress. Christian seems to recognize the validity of this criticism implicitly in his discussion but leaves it to Tamarin to challenge the multifactor model directly. Only the section on genetic organization in small mammal populations gives one some hope that small mammals can lead us to new insights into population dynamics.

If we do not yet have a good grasp of the population or community dynamics of small mammals, it is not surprising that Wagner has difficulty reviewing their management and control. The literature of this subject suffers even more from the statistical sins delineated by Hayne, and strength of belief is often confused with strength of evidence. But the economic importance of temperate-zone small mammals is usually low so no one really is affected by the present state of the art of small mammal management. In clear counterpoint Muul reviews the role of tropical small mammals in zoonotic diseases and provides several examples of how small mammal management impinges directly on human disease problems.

Small mammal research has passed the natural history stage and is starting into a challenging period. This symposium summarizes the old but is less good at giving us a stimulating guide to the new. Students of small mammal populations should read it with a critical eye. Arch Tryon, to whose memory the book is dedicated, would probably be pleased to see this symposium lead to a future small mammal symposium that is more analytical, more experimental, and more incisive.

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Insertion Phenomena

DNA Insertion Elements, Plasmids, and Episomes. Papers from a meeting, Cold Spring Harbor, May 1976. A. I. BUKHARI, J. A. SHAPIRO, and S. L. ADHYA, Eds. Cold Spring Harbor Laboratory, Cold Spring Harbor, N.Y., 1977. xiv, 782 pp., illus. $36.

One of the most revolutionary discoveries in molecular genetics in the past decade is that a number of specific DNA sequences existing at multiple locations on prokaryotic genomes can transpose or translocate spontaneously to new sites by a mechanism that is independent of the host's normal recombination system. When pairs of these insertion sequences (IS elements) flank a segment of the chromosome, the entire segment, including the two IS elements, forms a "transposable (Tn) element," which can be transposed as a unit to a new location. IS and Tn elements share many properties with some lysogenic viruses that insert into bacterial chromosomes. There are also indications that analogous DNA insertions may exist in eukaryotic cells. The 66 papers in this book review research on such insertions and attempt to define the problems and concepts that have emerged from it.

The introductory paper, written by the editors, is a concise and excellent overview of current knowledge about DNA insertions and provides an incisive introduction to the subject. The following paper, on nomenclature, is intended primarily for investigators in the field but should also be useful to casual readers.

The 26 papers in the first two main sections of the book describe how research on gene mutations, the regulation of genetic expression, the structure of extrachromosomal elements (plasmids and viruses) in bacteria, and the spread of multiple drug resistance have contributed to an understanding of DNA insertions in prokaryotes. Papers by Starlinger, Ohtsubo and Ohtsubo, Saedler, Heffron *et al.*, Brevet *et al.*, and Botstein and Kleckner provide excellent general reviews of one or more of these subjects. The other papers in these sections are more focused on their authors' own research. Because different IS-like elements have similar properties, there is a fair amount of repetition among the conclusions reached.

Section 1 deals with the simplest DNA insertions, IS elements. Different IS elements contain from 700 to 1500 DNA base pairs but do not appear to contain genes coding for functional products. The DNA sequences that are present in inverted repetition near the ends of IS elements may be significant because of their ability to insert in either orientation at many different sites on chromosomes. When they insert into a structural gene of a bacterial operon, IS elements may inactivate not only that gene but also the other structural genes of the operon, which are distal to the point of insertion of the IS element with respect to the regulatory genes, to cause polar mutations. Repeated isolates of different mutants have revealed only five common IS elements, although many DNA insertions remain to be characterized. Insertion is precise because the resulting polar mutations revert to prototrophy at low frequency (10^{-6} to 10^{-7}) to restore the original base sequence of the inactivated gene. IS elements may also excise im-

precisely at higher frequency (10^{-3} to 10^{-4}), resulting in deletion of part of the host genome without deletion of the IS element. IS elements are usually polar in both orientations, although some carry a strong promoter that can regulate adjacent structural genes in one of their orientations.

Rapid progress in the identification, mapping, and characterization of IS elements has been made possible by the development of powerful techniques for the analysis of DNA structure, most notably DNA heteroduplex methods and the use of restriction endonucleases. These techniques have shown that multiple copies of IS elements are normal constitutents of the bacterial chromosome and also of extrachromosomal genomes. The location of the IS elements on several bacterial plasmids suggests that they may play a key role in chromosome evolution, a possibility that is discussed in the book by several authors. In several cases identical IS elements in the same orientation have been located at the boundaries between specific blocks of genetic information governing functions such as antibiotic resistance, conjugal transfer, and plasmid replication. This is precisely what would be expected if the IS elements serve as sites for the fusion of two progenitor genomes, each of which originally carried a collection of specific genes and one copy of the IS element, to form a more complex genome specifying all the functions of each partner.

The alarming spread of multiple drug resistance among bacterial pathogens also appears to be a manifestation of the genetic plasticity made possible by DNA insertions. Experiments in several laboratories have shown that most drug-resistance genes on bacterial plasmids are flanked by repetitious DNA sequences, usually in inverted orientation, some of which have been identified as IS elements. The Tn elements thus constituted can be used to study the mechanism of transposition because their insertion into any site on the genome is accompanied by the acquisition of drug resistance. And because drug-sensitive cells must lack Tn elements it is also possible to monitor the lineage of a Tn element once it has been introduced into a bacterial strain, as is not possible with IS elements because of the multiple copies present.

The third and fourth sections of the book provide an interesting comparison of IS elements with more complex elements that insert into prokaryotic genomes. Temperate bacteriophages like μ (section 3) and λ (section 4) can exist as prophages inserted into the bacterial chromosome; after induction, they can excise and undergo autonomous replication prior to being packaged into virus particles. Thus, as a number of the authors note, the study of their life cycles should make possible a more systematic analysis of the mechanism of DNA insertion and excision. The properties of μ are reviewed most comprehensively in papers by Bukhari *et al.*, Toussaint *et al.*, and Chow and Bukhari. When μ inserts into a host chromosome during lysogeny, it integrates at random sites. During the lytic cycle of the phage, μ DNA continuously inserts and excises at many different sites on the host chromosome, acquiring different host DNA sequences at its ends. Why μ behaves in this way is a mystery, but the behavior is certainly reminiscent of the promiscuous insertion of IS elements, albeit at a much higher frequency and under conditions that are more amenable to experimentation. Mu can also mediate the integration of chromosomal genes into plasmids and thus may function in a manner analogous to IS elements in chromosome evolution.

The mechanism of insertion and excision of λ is now known in considerable detail. Although λ has a single highly preferred site for integration, the phage uses a variety of secondary sites when the normal integration site is deleted. There are a number of analogies between λ and IS and Tn elements, but it is not clear whether λ can be considered a Tn element.

There are increasing indications that repetitious DNA segments and Tn elements may also mediate the control of gene expression and chromosome interactions in eukaryotes. These possibilities are discussed briefly in the seven papers in section 5. For over 25 years, controlling elements having many of the characteristics of Tn elements have been hypothesized to explain differences in gene expression in maize. More recently, related models have been invoked to explain unstable phenotypes in *Drosophila* and mating-type interconversions in yeast. Analysis of the DNA from a number of eukaryotes and their viruses has also revealed the existence of inverted repetitious sequences.

The characterization of IS and Tn elements has led to the development of new methodologies that should be of broad applicability in the study of genetic rearrangements. A number of the techniques are described in section 6. The final 185 pages of the book contain four appendixes that provide detailed information about the genetic and physical structure and properties of IS elements, bacterial plasmids, and a number of temperate bacteriophages as well as a list of the restriction endonucleases and their recognition sites that were known at the time of publication.

The selection and organization of the contributions to the volume are commendable. Although there are a large number of contributors, the style of the papers is remarkably uniform. Most papers end with a concise presentation of their principal conclusions. The book should remain a unique and important contribution for years to come.

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