Chromosome Numbers

Polyploidy. Biological Relevance. Proceedings of a conference, St. Louis, May 1979. WALTER H. LEWIS, Ed. Plenum, New York, 1980. xii, 584 pp., illus. $55. Basic Life Sciences, vol. 13.

The nuclei of polyploids have a chromosome number that is a multiple of the basic gametic number of related diploids. Since polyploids have usually been recognized simply on the basis of their chromosome number, easy to determine with plants, botanists have accumulated counts of more than 35,000 species. Those with $n = 12$ or more are considered polyploid, and it is now estimated that between a third and a half of all flowering plants fall into this category. The more recent development of cytological techniques applicable to animals has made it possible to count their chromosomes also, leading to the discovery that certain parthenogenetic insects and many fish, amphibians, and reptiles are polyploid.

To understand the evident evolutionary impact of polyploidy, we will have to know how it contributes to adaptation. This in turn requires information on the production and maintenance of genetic variability in polyploid populations as well as insight into the developmental interactions peculiar to polyploid individuals. Since the majority of polyploids contain genomes that evolved independently (the degree of taxonomic separation of the diploid ancestors is not critical), this translates into a requirement for understanding hybridity (the effect of possessing different alleles at the homoeologous loci of divergent genomes) and increased gene dosage (the effect of chromosome multiplication).

This book brings together 27 papers from an international conference on polyploidy. A number of biological disciplines were juxtaposed: systematics, cytogenetics, physiology, plant breeding, entomology, and vertebrate zoology. The result is a book that accurately reflects the variety of research now being done with polyploids. In addition, it organizes and summarizes much knowledge not readily available elsewhere. However, many of the questions that seemed appropriate in the 1950's, a decade when chromosome counting and speculation on phylogenetic relationships were often acceptable research, still persist, and polyploidy continues to be viewed primarily as a chromosomal phenomenon rather than as a problem in genetics and development.

A major emphasis of the book is on description of the taxonomic distribution of polyploids throughout the plant kingdom with extensive compilations and frequent comments at the family or genus levels (Nichols, Maniotis, Crosby, Wagner and Wagner, Delevoryas, Goldblatt, and Lewis). Similar information is gathered for insects (Lokki and Saura), fish (Schultz), and amphibians and reptiles (Bogart). An interesting contrast emerges between the botanists and the zoologists. Chromosome numbers are accumulated by the botanists primarily as an aid in constructing phylogenetic schemes and correlations between ploidy levels and factors such as geographical distribution, plant community, and role in succession. The zoologists as a group find it necessary to demonstrate that animal polyploids are not evolutionary "dead ends" as has been widely thought. Having fewer species to study than the botanists and being less concerned with phylogeny, they spend much of their effort documenting the often substantial genetic heterozygosities and broad ecological amplitudes of various polyploid animals. The vignettes of polyploid weevils, beetles, and other insects, all parthenogenetic and usually flightless yet generally more widely distributed than related sexual diploids, and the descriptions of polyploid frogs and fish are frequently fascinating.

In addition to the review of polyploidy in systematics, the botanical papers are devoted to mode of origin (deWet), cytogenetics (Jackson and Casey), correlation with geographical distribution and plant community (Ehrendorfer), and physiology (Tal). Stebbins also contributes an enthusiastic review. An important recent discovery is that the origin of most polyploid plants involves cytologically nonreduced gametes rather than "spontaneous" chromosome doubling in zygotes or apical meristems. DeWet points out that at least two generations are required: a diploid female gamete ($2n$) fertilized by a haploid male gamete (n) yields a triploid individual ($3n$) that in turn produces triploid female gametes ($3n$) that must be fertilized by haploid gametes (n) from a diploid to produce tetraploid offspring ($4n$). The particular gamete source and the structural homology of the chromosomes that are brought together directly affect fertility and recombination in the polyploid product, a subject authoritatively reviewed by Jackson and Casey.

The scanty data on physiological attributes of plant polyploids indicate that most parts of the plant respond to chromosome multiplication, but cause and effect remain unclear. This may be because the comparisons have emphasized general quantitative changes at the level of ion balance, water relations, total RNA, and auxin, for example, rather than specific processes or characters, particularly those that could be related to genetic control. In addition, the physiological studies continue to reflect the common but unsupported notion that everything depends on everything ("The specific contribution of gene multiplication is not necessarily related to a specific structure or process, but is most likely a result of the integrated functioning of all components of the organisms").

Since many cultivated plants are polyploid, plant breeders and others have closely examined allelic segregations and the cytogenetic complexities of polyploids. Among the authors dealing with polyploid crops in this volume, Müntzing reviews the history of attempts to construct the new grain crop triticale by combining the genomes of tetraploid and hexaploid wheats with the diploid genome of rye. Kimber and Sears describe the very elegant genetic capabilities of the aneuploid series in wheat. The most stimulating papers are those by Dewey and Bingham. Dewey's honest and thoughtful appraisal of induced polyploid crops concludes that their performance has not matched the initial enthusiasm at their introduction, but points out their value in transferring specific genes between chromosome races and species. Bingham presents his outstanding research to maximize genetic heterozygosity in populations of autotetraploid alfalfa, an outcrossing crop for which there is an unambiguous correlation between heterozygosity and yield.

Unfortunately, much of the rich and detailed research on cultivated polyploid plants seems to have had little impact on the broad field of plant evolution and

systematics (with the exception of the work on cytogenetics). This may be because plant evolutionists continue to follow the so-called "synthetic approach," which stresses studies at many different levels of organization from plant community and ecology to cytology and morphology. Although seemingly faultless in conception, the results of this approach have been at the level of survey and correlation and rarely have tested rigorously framed hypotheses. In the present volume, this is clearly evident in the contrast between the papers by many of the botanists and the more disciplined treatments by the breeders and cytogeneticists and several of the zoologists.

In sum, the usefulness of the book is primarily in its substantial amount of current information. But even though polyploids are wonderful natural experiments in gene regulation and interaction, most of the research described does not seem directed toward integrating this field with results in other relevant areas, particularly molecular genetics and development.

L. D. GOTTLIEB
Department of Genetics,
University of California, Davis 95616

Plant Physiology

Plant Membrane Transport. Current Conceptual Issues. Proceedings of a workshop, Toronto, July 1979. R. M. SPANSWICK, W. J. LUCAS, and J. DAINTY, Eds. Elsevier/North-Holland, New York, 1980. xviii, 670 pp., illus. $73.25. Developments in Plant Biology, vol. 4.

The study of ion transport into plant cells presents considerable problems for the investigator. The presence of a wall and vacuole makes special difficulties for those who want to probe membrane processes. As if this were not sufficient, the cells that have proved most easy to probe electrically—those algae that produce "giant cells"—cannot readily be made to provide large amounts of material, and those cells that can be cultured can only with difficulty be encouraged to give the sort of yield of uniform cells available to the bacteriologist or to the animal physiologist investigating ion transport into blood cells.

This volume presents the proceedings of the fourth international workshop on this subject since 1972. Nearly all the major investigators in the field contributed to the book. Some contributions are ones invited by the organizers, some are confined to two pages and summarize posters, and others are in the fully recorded discussions. The reader therefore has a broad representation of plant membrane studies.

Does the book constitute a good statement about the state of the field? Well frankly, no. The invited contributions vary from reviews to presentations of hitherto unpublished data, and although the contributors were asked to "place special emphasis on problems and issues that deserve attention in future studies" the reader frequently finds that it is difficult to obtain a clear idea of what they are. A good model for the other contributors would have been the excellent review by Walker of the transport systems in charophyte and chlorophyte giant algal cells. It is an admirable attempt to produce some order in what is already known, to indicate technical problems by using experimental data, and to provide a look into the future.

But I have a more fundamental worry. The volumes produced from the first meetings, at Liverpool and Julich, were exciting to read because the Liverpool meeting was the first coordinated expression of ideas that were bubbling to the surface in the early 1970's, and the Julich meeting built on what had been done at Liverpool, producing a comprehensive statement of knowledge. But the present volume has an inward-looking, slightly incestuous air. There are signs that certain concepts, particularly chemiosmosis, are getting dangerously popular. In a chapter entitled "The chemiosmotic viewpoint" Raven and Smith deal with the subject at length, yet in the reported discussion Raven admits to having difficulty in defining what is meant by chemiosmosis. Several other authors refer to the process with even less clarity. There is an atmosphere about the subject reminiscent of that of the 1950's, when there was an obsession with anion respiration. Plant physiologists then paid the penalty of allowing theory to dominate their thinking about ion transport into plant cells and at the same time failed to pay attention to the significant advances that were being made by those working with animal cells. A similar situation could occur again, compounded by the fact that there are relatively few workers in the field and that they use a variety of cellular systems, most of which are difficult to probe. The catalog includes bacteria, a plethora of algae, lower and higher fungi, lower green plants, and some 30 genera of flowering plants from which various cells and organs have been chosen for study. The volume provides little guidance about how we might progress from this situation, particularly biochemically. Control of transport is one of the themes that emerges somewhat tentatively from the volume, but it is unlikely that much more of substance can be said until we have a clearer idea of the molecular nature of the transport processes that are being controlled. As it is, there is still an overemphasis on biophysics in plant membrane transport studies, the bulk of the papers in the volume being so concerned.

D. H. JENNINGS
Department of Botany,
University of Liverpool,
Liverpool L69 3BX, England

Visual Adaptations

The Ecology of Vision. J. N. LYTHGOE. Clarendon (Oxford University Press), New York, 1979. xii, 244 pp., illus. + plates. $57.20.

It is difficult to imagine two subdisciplines of biology more different from one another than ecology and visual science. The latter has become reductionist in approach and mechanistic in analysis, centering on the eye in isolation, the particular neuron within the visual system, or the particular molecule extracted from the visual cell, whereas the former embraces and celebrates the complexity of the functional connections between organisms. It is clear that animals' interactions with the environment are dependent upon recognition of its salient features and that vision is the dominant sense of many animals, but visual scientists do not offer much help to the ecologist who wishes to know how an animal sees its surroundings. They have attempted quite successfully to analyze visual performance objectively but in the process have created a set of subdisciplines so numerous and arcane that they are almost impenetrable by the novice. Most books purporting to summarize vision are directed toward psychologists and physiologists. The ecologist or natural historian interested in the subject has been largely dependent on Walls's celebrated tome of 1942, *The Vertebrate Eye and Its Adaptive Radiation*. In the ensuing years, our understanding of vision in both vertebrates and invertebrates has advanced considerably. Lythgoe has incorporated some of these advances into his book, and the result is quite successful.

The book is composed of seven chapters. The first summarizes the physical aspects of light on earth, the second visual mechanisms. The remaining five deal with particular kinds of visual situa-