nevertheless has the scientist's faith that only the isolation and control of variables will yield trustworthy data. The book is useful, therefore, in showing the anomalies, puzzles, and complexities of the existing data on the perception of size and distance.

Physiological optics and the concept of the retinal image are accepted as the basis of perception. The author thinks of space perception as the seeing of the sizes and distances of objects in empty air, which justifies his title. The doctrine of *cues* for the third dimension of space is taken for granted. He is uninfluenced by the recent tendency to think of space perception as the seeing of the layout of surfaces in a terrestrial world as distinguished from the seeing of objects in the sky.

The investigation of the tendency toward invariance in the phenomenal size of objects with varying distance has become a genuine specialty in modern psychophysics. There is a large body of research here surveyed. The reader may judge whether or not any pattern has emerged. If so, it is obscure.

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Agricultural Improvement

Outlines of Perennial Crop Breeding in the Tropics. F. P. FERWERDA and F. WIT, Eds. Veenman, Wageningen, The Netherlands, 1969. xvi, 512 pp., illus. Paper, N.fl. 49.50. Landbouwhogeschool Miscellaneous Papers, No. 4 (1969).

Many tropical countries are dependent largely upon agriculture, and perennial crops are often a major source of their income. The number of plant breeders working with tropical perennial crops is small compared with their colleagues in temperate countries, but their contributions have often been immense. The breeding of vigorous, high-yielding, disease-resistant, interspecific hybrids of sugar cane, a crop rather surprisingly not included in the volume under review, has been of the greatest value. The best clonal *Hevea* rubber gives three to four times the yield of the nonselected seedling material of 50 years ago and has permitted the industry to survive in competition with synthetic rubber. However, this measure of success has not been achieved with all crops. Although we now know a very great deal about the origin and cytogenetics of bananas, we are still only on the threshold of breeding useful commercial cultivars of this crop.

The editors of this volume, which "is intended as a guide to the student and a source of reference to the scientists in the tropics," have brought together contributions from 28 specialists of different nationalities on a wide range of crops. The crops dealt with are agave, avocado, banana, cacao, cinchona, citrus, clove, coconut, coffee, date palm, fig, kapok, kola, mango, nutmeg, oil palm, papaya, pepper, rubber, tea, and tung. In addition to sugar cane, crops omitted include cashew, guava, passion fruit, pineapple, pyrethrum, and vanilla. For each crop information is usually provided on systematics, physiology of development, floral biology, breeding, and possible future developments. The lists of references seem to be adequate and reasonably up to date.

Many perennial tropical crops are very heterogeneous and, although in many cases it is possible to perpetuate the clone by vegetative propagation, the genotype can be improved only by purposeful breeding. The importance of preserving variability in gene banks before some is irretrievably lost should be stressed. Because of their long breeding cycles, genetic improvement of these crops entails long-term projects, often with inevitable changes of staff, particularly in recent years. The published results are often fragmentary and dispersed. The bringing together of the information in this way should be much appreciated by present and future workers in this field.

One of the most important aspects of crop improvement is the breeding of disease-resistant cultivars. The discovery of coffee leaf rust, *Hemileia vastatrix*, earlier this year in Brazil, when it had already invaded a substantial area in eastern Brazil, may well have far-reaching consequences for the political and economic stability on those South and Central American countries which depend largely on coffee, particularly as the New World crop appears to be susceptible to nearly all the races of the rust. Ferwerda, in the chapter on rubber, describes the attempt being made to breed clones resistant to South American leaf blight, *Dothidella ulei*, in Liberia and testing them out in Guatemala, where the disease is endemic. Of the 7542 clones tested, only 1.7 percent exhibited resistance, and the advent of new, extremely virulent physiological races of the pathogen has added further complications. No reference is made to work of a similar nature which is being carried out by the Rubber Research Institute of Malaya in Trinidad.

The book is well produced and illustrated; it is commendably free of typographical errors. It can be recommended to all who are interested in the improvement of tropical perennial crops. It is sad that Toxopeus, one of the first joint editors, to whom this volume is now dedicated, did not live to see its completion.

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Mechanisms of Inheritance

Genetic Organization. A Comprehensive Treatise. Vol. 1. ERNST W. CASPARI and ARNOLD W. RAVIN, Eds. Academic Press, New York, 1969. xiv, 528 pp., illus. $29.

Starting with an unusually interesting historical introduction (by L. C. Dunn), this first volume of a set of three deals with the structure of nucleic acids (H. M. Sobell) and chromosomes (J. H. Taylor), genetic transformation and recombination (W. F. Bodmer and A. J. Darlington; S. Emerson), and chromosome pairing (R. F. Grell). The later volumes are to deal with gene action, mutation, and evolution.

The first application of scientific method to the study of the laws of inheritance led to the concept of genes as particulate units of inheritance, normally stable but subject to rare, sudden inheritable changes called mutations, a term borrowed from paleontology. As the history of genetics is traced in Dunn's account, it seems that the most farsighted achievement of the early work was the recognition of the genetic apparatus as a chemical system, requiring the application of physical and chemical methods for its elucidation. Garrod, who was a chemical pathologist studying congenital metabolic disorders in man, aptly referred to these disorders as "inborn errors in metabolism" and introduced the concept that the enzymes of metabolism might be controlled by genes. Avery discovered that pneumococcal transformation was due to a fibrous polymer, deoxyribose nucleic acid, and so opened the way for Watson and Crick to arrive at the molecular structure of

the gene-carrying substance DNA. Since then, the structures of many natural and synthetic polynucleotide chains, as well as paired nucleotide crystals, have been determined, and this work is conveniently summarized in Sobell's chapter on nucleic acid structure. This information is pertinent to special situations involving hydrogen bonding, as in the origin of the alternating dAT polymer formed by unprimed DNA polymerase, or codon-anticodon interaction and Crick's wobble hypothesis. Recent progress has been remarkable in the determination of the base sequences of the transfer RNA molecules and *5S* ribosomal RNA This information has implications for the tertiary structure of these functional molecules, although much remains to be learned of the signficance of these sequences.

What is the structure of the chromosome and how does recombination take place? The remaining authors deal with these questions. Higher organisms contain great lengths of DNA coiled up in a remarkably compact form in the condensed chromosomes seen at cell division. The indications are, at least for the lampbrush chromosomes of amphibian oocytes, that chromosomes contain few, and perhaps only two, DNA duplexes running along the length and maintaining axial continuity. Most chromosomes behave genetically, in replication and in joining following breakage, as if based on a single duplex that is replicated during the synthetic period of interphase, but there are notable exceptions in the giant polytene chromosomes of insect salivary glands, which have many hundreds of parallel duplexes.

Recombination has long been one of the favorite topics for investigation by geneticists. It has been argued that recombination may take place by copy choice, by cutting and joining, or by cutting and joining with local copy choice. Bacteriophage crosses are favorable for investigating the molecular mechanisms of recombination, and in phage λ crosses recombinants can be recovered that must have been formed by cutting and joining, although it remains uncertain whether the phage integration system or the phage and bacterial recombination systems was responsible for their production. Bacterial transformation, another form of recombination, appears to depend upon the integration of a single strand of donor DNA. Recombination in higher organisms during meiosis is of particular interest, because all the products of recombination can be recovered and are usually reciprocal, the rare exceptions usually being attributed to the local repair synthesis at the join. Extensive data from meiotic recombination in fungi have been accumulated in the hope of establishing the underlying mechanism, and various models have been proposed. It is widely assumed that mismatched base pairs are recognized by an endonuclease and excised, for this permits the freedom in model building needed to explain any data, yet the experimental tests on this question are most unsatisfying. One can hope that model building has reached its peak and that these models will be displaced as more is learned about the specificities of the pertinent nucleic acid enzymes. The final chapter, by Grell, is concerned with the long-range and short-range forces of chromosome pairing and the role of the synaptinemal complex. The relevant experimental material is reviewed, but the questions cannot be definitively answered.

This book brings together the wealth of experimental material pertinent to the problems of recombination, and can be warmly recommended as an up-to-date, scholarly, and comprehensive treatise. We look forward to the appearance of the subsequent volumes.

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Marine Algae

Biology of Acetabularia. Proceedings of a symposium, Brussels and Mol, Belgium, June 1969. JEAN BRACHET and SILVANO BONOTTO, Eds. Academic Press, New York, 1970. xvi, 304 pp., illus. $10.

When I first read about Hämmerling's experiments with *Acetabularia*, published in the 1930's, I found it hard to believe them. It seemed to me highly improbable that there should exist a plant a few centimeters long but with only a single nucleus at one end. I cannot have been the only person to have such skeptical reservations, because it evidently took 20 years before biochemists awakened to the almost unique potentialities of this remarkably operable organism. Lop off its base, with a pocket knife if you like, and you have an anucleate cell: how simple, and how useful! Furthermore, although they are marine algae, some species of *Acetabularia* aren't hard to grow; indeed, the finest cultures that I've seen were in a laboratory in central Siberia, far from the briny breezes of the Mediterranean or the West Indies where *Acetabularia* swards flourish naturally.

It is to Brachet, more than to anyone else, that we owe this renaissance of interest in a lowly chlorophyte. It is to him, too, that we now are indebted for a stimulating book, the proceedings of a symposium on the subject held in Belgium a little more than a year ago. Congratulations, Academic Press, for getting the book out so expeditiously! In the circumstances, it might be uncharitable to carp at the odd syntax of some of the articles; at least they are all written in English or in what I have heard called "the international language of science, broken English." And Academic Press, or someone, has at least found time to prepare an adequate index, without which it would be difficult to ferret out much of the information in a symposium volume of this sort. I wish, though, that they'd worked a little more on the graphs and tables, many of which I found quite hard to understand, and some of which I suspect we might have done better without.

The title of the book is perhaps a trifle more all-embracing than the content would justify. Some aspects of the biology of *Acetabularia*—its ecology, say—receive little or no attention. What the book does deal with is the fashionable side of biology today: the fine structure of the wall, the plastids and certain other subcellular particles, their fractionation, and their biochemical activities. *Acetabularia* species lend themselves peculiarly well to investigations of morphogenesis; but I have the impression that most of the studies described here have somewhat gingerly skirted the crux of the problem. After all, it's easier to extract and measure the DNA or RNA from plants or fractions subjected to various treatments than it is to find out exactly how they make the little lampshades that characterize this genus.

There are 16 articles, of which 7 are by Brachet and his Belgian colleagues, and 5 by compatriots of Hämmerling, the German father of scientific acetabulariology. I recommend that the "Concluding remarks" by Brachet be read first; they help to put the other contributions into perspective, and to distill the essence of the researches from the "long succession