of polysaccharides can be combined with C^{14}-labeled sodium cyanide to give a cyanhydrin that on saponification yields a radioactive carbohydrate containing one carbon more than the parent polysaccharide. The reaction, which is the well-known cyanhydrin synthesis, converts a 6-carbon reducing end group to a 7-carbon unit containing a radioactive carboxyl. The presence of the carboxyl permits the separation and purification of the material by means of ion exchange resins. Thus absorption of the carboxyl derivative on a basic resin separates it from any unreacted polysaccharide, and elution of the absorbed material with aqueous ammonia provides a highly purified radioactive product. On account of the high sensitivity of radioactivity measurements, the combining proportion of the radioactive cyanide can be determined accurately. This is a measure of the average molecular weight of the reacting polysaccharide. The procedure provides not only a new tool for structural studies, but also a means for labeling carbohydrate material for biological and other investigations. Furthermore, it constitutes a sensitive method for ascertaining the number of carbonyl groups in a substance of known molecular weight. Reaction of polysaccharides with cold cyanide yields products that may have useful properties. The procedure is particularly suitable for the study of polysaccharides of relatively low molecular weight, and partially hydrolyzed products.

HORACE S. ISBELL

National Bureau of Standards
Washington, D. C.

Book Reviews

Crystal Growth. H. E. Buckley. New York: Wiley; London: Chapman & Hall, 1951. 571 pp. $9.00.

Anyone faced with the necessity of growing "perfect" crystals of any considerable size should first read this book. He will find it a bit slow going here and there, partly because of the author's weakness for long sentences (the first sentence on page 7 consists of 90 words), and partly because of his liberal use of "former" and "latter." If the reader is not disturbed by this he will find he has a very useful reference book.

The 12 chapters range from "The Artificial Preparation of Crystals" and "Theories of Crystal Growth" through "Modification of Crystal Habit by Impurities" to "Relationship of Substances during Crystallization." The thoroughness with which the author has covered his topics may be judged by the fact that he lists over 650 references to the literature, coming from the publications of more than 475 authors. The book contains 169 figures and 88 plates, all of high quality.

WHEELER P. DAVEY

State College, Pennsylvania

Problems of Cytology and Evolution in the Pteridophyta. I. Manton. New York: Cambridge Univ. Press, 1950. 316 pp. $8.50.

Most recent books dealing with the synthetic approach to problems of evolution have discussed, primarily, general principles, with illustrations taken from various groups of animals and plants. These books have established certain principles and methods of attack on evolutionary problems, on which there is an ever-increasing amount of agreement. The logical sequel to these works is a series of many-sided attacks on problems of evolution in particular groups of animals and plants. One such attack is the volume by Dr. Manton on the Pteridophyta, and it is one which sets a very high standard.

Upon even a casual examination of the book, one is impressed by the amazing technique Dr. Manton has developed for studying the cytology of the Pteridophyta. Ferns and their allies have always been regarded as extremely difficult material for chromosomal studies. Their chromosome numbers are very high, and their somatic chromosomes are usually long, slender, and entangled among each other so that they are difficult to count. Furthermore, their cytoplasm often contains heavily staining inclusions, which tend to obscure the chromosomes. As a result, before Dr. Manton began her work, the numbers of few species were known with exactitude. But the present volume contains page after page of photographs and drawings of meiotic smear preparations in which gametic numbers which range from $n = 13$ (in *Hymenophyllum tunbridgense*) to $n = 108$ (in *Equisetum* spp.), and even $n = 256$, recorded in *Ophioglossum vulgatum* as the highest chromosome number known for any living organism, can be counted by the reader either exactly or with a reasonable degree of accuracy. Dr. Manton's techniques, which would require much patience and experience to reproduce successfully, are nevertheless well described in an appendix, so that anyone who desires to and has sufficient skill may follow in her footsteps.

The text may also be commended for its readability. Dr. Manton has achieved a fine balance between scientific precision and a personal narrative style. While learning a multitude of hitherto unrecorded facts about the interrelationships among the fern species of northern Europe, the reader accompanies her on field trips to the native habitats of many of them, on explorations through the rich literature on their systematics and morphology, and in her contests with them as refractory cytological objects. For instance, she writes as follows about the well-known boreal and

high montane species of club moss, *Lycopodium selago*:

> . . . here the cytologist's troubles reach a climax in spite of the ease of cultivation and other advantages which one might expect would facilitate the task. In actual fact this species is, in my experience, the worst cytological object that I have ever encountered, and in the unequal contest between cytologist and plant, the plant has in this case so far won handsomely.

Most of the material is from Dr. Manton's own researches of the past 20 years, here presented for the first time. Her most important results are as follows. Each genus of ferns is shown to have a single definite basic chromosome number, and in cases where more than one number is recorded for a genus, as in *Dryopteris,* good morphological evidence is presented for recognizing more than one genus—these generic segregations being in accord with the opinions of one or another well-known specialist in pteridophyte taxonomy. Cytology has thus provided good evidence for deciding many of the disputes between taxonomists as to the generic status of certain groups. Furthermore, similar chromosome numbers found in different genera often point the way toward a settlement of disputes concerning generic affinities. Thus *Polystichum* and *Dryopteris, sensu strictu,* both have the basic haploid number $x = 41$, and show their relationship in various morphological features; whereas *Thelypteris,* which is united with *Dryopteris* by some authors, has $x = 34$ and $x = 35$, and so appears to be more distantly related, as one might suspect from its superficial appearance and habitat.

The basic numbers in the family Polypodiaceae range from a probable $x = 29$ in *Pteris* and *Pellaea* to $x = 52$ in *Pteridium.* In the Osmundaceae all genera have $x = 22$, in the Hymenophyllaceae $x = 13$ and $x = 18$, and in the Ophioglossaceae $x = 45$ and $x =$ *ca.* 128. Among the other Pteridophyta, similar high basic numbers are recorded, except in *Isoetes,* with $x = 10$, and *Selaginella,* with $x = 9$. *Lycopodium* is the only genus with several rather different basic numbers, and on this basis Dr. Manton suggests that the British species of *Lycopodium* (p. 252) ". . . seem now to be far more different from each other than are the genera or even groups of genera of the Polypodiaceous ferns. This is perhaps a sign of antiquity."

Dr. Manton does not discuss directly the fact that immediately strikes anyone familiar with the cytology of the higher plants, namely, that the basic chromosome numbers of genera of Pteridophyta are much higher than those of Angiosperm genera. She suggests that aneuploid changes have resulted in increasing basic numbers, but an equally valid hypothesis is that the genera themselves are of ancient allopolyploid origin, and that the phylogeny of the various families is highly reticulate. If this were true, the great differences between the opinions of specialists on the phylogeny of the Pteridophyta would be made understandable, though not resolved.

Within nearly every genus Dr. Manton has recognized polyploid series, often involving types that systematists have placed in the same species. In some instances she has produced clear evidence that species with higher numbers are allopolyploids, derived by hybridization and chromosome doubling from species with lower numbers, the identity of which she has determined. Furthermore, the polyploids of uncertain derivation nearly all have characteristics of allopolyploids, so that autopolyploidy appears to have played a negligible role in the evolution of the Pteridophyta. This part of Dr. Manton's work would have been much more meaningful if she had been able to study the species complexes throughout their entire range, rather than in Great Britain and northern Europe alone.

The problem of apogamy, both natural and induced, is carefully treated. In several different genera, the apogamous sporophytes are shown to arise from diploid gametophytes, which in turn are produced by diploid spores. Such spores result from regular meiosis in tetraploid spore mother cells, which in turn are produced by a process of chromosome doubling by means of abnormal mitoses in the archesporial cells. When this premeiotic doubling does not take place, meiosis in the apogamous species is very irregular, and indicates their hybrid origin.

Among the general conclusions is the one (p. 283) ". . . that polyploidy as such is not in itself either ancient or modern or an adaptation to cold or any other single climatic or ecological factor, but . . . is correlated with climatic or geographical upheavals however caused." This conclusion resulted from a comparison between chromosome numbers of the ferns of Great Britain, where most of the polyploids appear to be of Pleistocene origin, with the numbers found on the island of Madeira, where the polyploids are apparently much more ancient, though just as numerous. A second conclusion is that hybridization between species has been very frequent, many hybrids having been recognized in the European flora. A very different cytological phenomenon, alteration in chromosome shape, is important in some groups, particularly in *Lycopodium* and its relatives, in which the chromosomes at meiotic metaphase are in a remarkable despiralized condition. Chromosome size appears to diminish as the numbers increase. This increase in chromosome numbers must be due to the high survival value of the higher numbers, which is only partly explained. The ability of allopolyploid species to survive in new habitats, while their parents become extinct with the disappearance of old habitats, is suggested as an important cause.

Dr. Manton has reached certain conclusions about evolution in general. The first of these is (p. 290), ". . . evolution, as such, is a phenomenon for which no cause need be assigned other than the fundamental instability of living matter." Her second is that the numerous examples of parallel evolution within the Pteridophyta will be eventually explained through an understanding of the molecular and atomic structure of their chromosomes. Although she denies belief in

orthogenesis as some "inscrutable mystic force," she nevertheless believes in internally directed evolutionary trends of some sort. In the opinion of the present reviewer, all the examples of parallelism that she mentions can be explained on the assumption that similarly constructed, though distantly related, organisms will react similarly to the same or parallel changes in the environment.

To the specialist on the Pteridophyta, Dr. Manton's book will have a value approaching those of Bower and the other great authorities of the past. To the student of plant evolution in general, it will serve as both a stimulus and a challenge to produce similar studies of such high excellence in other groups of plants.

G. LEDYARD STEBBINS, JR.

Division of Genetics
University of California, Davis

The Perception of the Visual World. James J. Gibson; Leonard Carmichael, Ed. Boston: Houghton Mifflin, 1950. 235 pp. $4.00.

This book presents an interesting discussion of visual perception, written as only a psychologist thoroughly familiar with the language of the Gestalt school could write. It is an exposition of ideas worked out during a war research project on the visual perceptual problems of the aircraft pilot.

The essential theme is "that visual space-perception is reducible to the perception of visual surfaces, and that distance, depth, and orientation, together with the constancy of objects may all be derived from the properties of an array of surfaces." In line with the concepts of the Gestalt psychologists, who have insisted that the perception of form is a fundamental sense response, and is not merely an intellectualized summation of individual parts of the form, Dr. Gibson makes the hypothesis that the spatial and temporal changes in the retinal image patterns of textured surfaces constitute the fundamental sense response for the perception of depth and distance. The change in the angular size of the details of the texture of surfaces, such as that of the ground as it recedes into the distance, he calls a "gradient." The perception of the slant and apparent distance of the surfaces are immediately and directly perceived through these retinal image gradients.

The greater part of the book is concerned directly with the concepts of gradient, the relationship of the gradient to the retinal image as the stimulus. Not only does this include the concept of texture gradient, but also the convergence of parallel lines in perspective which is a gradient. The relative intensity of shadow or illumination on solid objects constitutes a gradient. Binocular vision and stereopsis are a response to abrupt changes in gradients. Aerial perspective is an aspect of gradient. Of considerable interest, also, is the author's discussion of change of deformations in retinal image gradient with motion; that is, motion of objects and of the observer. Even the rate of changes of motion, a rate of change in gradient, results in a psychologic correlative of acceleration.

Of special interest is Gibson's hypothesis that the so-called size constancy phenomenon (wherein objects are perceived in their true size regardless of their distances) is accounted for in terms of the gradient of textured surfaces. Associated with the perception of gradient is a psychologic size scale carried by each person which provides the basis for perception of the size of objects, the objects always being associated with the gradient of the background surface.

The last chapters cover the controversial subjects of learning, the effect of learning upon perception, and the essence of meaning in perception of form and depth.

It would certainly appear that gradients in retinal image patterns could not of themselves provide a reliable guide to absolute spatial localization. Knowledge of the nature of the detail that makes up the texture of surfaces, as well as postural influences of the individual, must be determining factors. The change in angular size of detail varies inversely as the square of the slant distance from eye to surface, and the gradient has symmetry around the foot of the perpendicular line from eye to surface. Hence, even a vertical surface can exhibit the same gradient of details as can a horizontal one for the same perpendicular distance.

This book provides much food for thought on the general problem of perception, although at times it leaves the critical reader somewhat unsatisfied, as perhaps it should. Much research, as Dr. Gibson points out, will be necessary to validate these hypotheses. The book is recommended for those particularly interested in the visual sense, but even the casual reader will find it readable and instructive.

KENNETH N. OGLE

Section on Biophysics and Biophysical Research
Mayo Foundation and Mayo Clinic

Plant Biochemistry. James Bonner. New York: Academic Press, 1950. 537 pp. $6.80.

The subject matter of plant chemistry would seem to be of primary importance to biology as well as to agriculture and substantial segments of industry. It is curious, therefore, that texts dealing with the chemical composition and metabolic activities of plant life have appeared only infrequently over the years; and these have not been notable for their grasp of subject matter or problems. Publication of this text by Bonner has, for the first time, presented the student and the researcher with an integrated source of relatively up-to-date information. Whatever may be found wanting among its pages, this pioneering treatment is bound to prove of substantial use to those interested in plant science and technology.

The author chose one of several possible outlines of subject matter. Indeed, the difficulty inherent in choosing any single organizational pattern is well expressed in his first chapter, ". . . the subject matter of this book is cyclical rather than linear in arrange-