

the twin determinants of tree form, architecture and reiteration. The concept of genetically expressed growth form (architecture) and the development of a standardized nomenclature provide "the syntax by means of which we are beginning to understand tree construction." Francis Hallé goes on to explore a causal phylogeny of tree models, noting the importance of trying to bring together taxonomy, the study of plant parts, and the study of the developmental morphology of the whole plant.

But many aspects remain unclear—for example, roots and root systems. Jan Jenik, in summarizing current knowledge of root systems, finds it impossible to establish a hierarchic system of types according to a few diagnostic features and concludes that a classification of the entire root system of tropical tree species is bound to be incomplete and premature.

One of the most revealing contributions, by John Dransfield, deals with the relation between the growth form and the habitat of palms. Although conspicuous in the structure of rain forests and a favorite among taxonomists, palms have attracted little ecological attention. Our ignorance of their ecological relationships is indicated by Dransfield's having had to go back to the turn of the century and before for literature sources. There is certainly great scope for further ecological study of this most interesting and versatile group of tropical trees.

The forest comes alive in a remarkable paper by Roelof Oldeman on energy exchange and distribution. Oldeman resolutely avoids the ambiguous and counter-productive use of the term "succession." Instead, he produces a striking model of sylvigenesis, which is used to characterize the processes by which the forest develops, including many partial processes continuing through successive dynamic and steady phases in shorter or longer cycles. Oldeman revives the word "chablis," which was used by foresters in medieval France, to describe the fall of a tree, its impact on the forest, and the associated destruction that initiates a cycle of distinct energetic environments and regeneration. Tree falls, canopy gaps, and forest dynamics are also discussed by Gary Hartshorn and T. C. Whitmore, but their approaches are much less original than Oldeman's.

Since this is a book that aims to foster further ecological research in the tropics, one point needs emphasizing. Despite the contributions of Herbert Baker and Daniel Janzen, the roles of animals in community interactions and reproductive strategies are dealt with in a disap-

pointingly meager fashion. If the gap in our knowledge of this subject is so great that not much more could have been said, then Baker's rather stern injunction deserves quoting in full:

In order that some progress may be made toward remedying such deficiencies, I suggest that, in future, no autecologic study, let alone any synecologic investigation, should be considered satisfactorily accomplished if it does not include some information on the pollination biology, breeding systems, seed dispersal mechanisms, seed germination requirements, and seedling establishment peculiarities of the plants concerned. The roles of animals at all stages of the reproductive processes of the plants need to be elucidated.

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Early Events in Vision

Vertebrate Photoreception. Papers from a symposium, London, Sept. 1976. H. B. BARLOW and P. FATT, Eds. Academic Press, New York, 1977. xx, 380 pp., illus. \$29.

Understanding the workings of our sensory windows remains a central concern of neurophysiology. Probably more effort has been devoted to unraveling the mysteries of vision than those of any other sensory modality, and this book describes some of the recent successes that have been obtained with the light-sensitive cells of the vertebrate retina.

The late Lord Rank, whose highly successful career in British industry embraced a wide range of interests, left a handsome endowment for the Rank Prize Fund for Opto-electronics. The committee that administers these funds has sponsored two conferences and has been imaginative in its selection of topics. This volume reports the proceedings of the second conference and includes not only the 20 papers that were presented but the ensuing discussions by the approximately 100 researchers in attendance. The organizers (Barlow and Fatt) chose not only to emphasize the earliest events in the visual response of vertebrates but to steer a course around most of the biochemistry of rods and cones. The reader will therefore find that some subjects of current interest—roles of cyclic nucleotides and phosphokinase and much of adaptation, for example—are not covered. In spite of this limitation the book achieves considerable success in conveying the active state of this field.

Most of the papers have to do with one of two topics. The first of these is the "intracellular transmitter," through which a photoactivated molecule of visual pigment, located in the disk membranes of the outer segments, reaches out to modify the permeability of the plasma membrane at sites several micrometers distant. Several years ago Yoshikami and Hagins proposed that Ca^{2+} ions are the internal transmitter. This idea has inspired considerable experimental effort, but a definitive demonstration of its validity has proved elusive. One of the difficulties, emphasized in the chapter by Daemen *et al.* on Ca^{2+} binding by receptor membranes and adenosine triphosphate-dependent uptake of Ca^{2+} by outer segments, is the fragile nature of the rod outer segment. Practically anything the biochemist may do to obtain clean preparations causes the outer segments to leak Ca^{2+} ions. Difficulties of this sort have spawned inventive approaches. Reconstituted vesicles of phospholipid membranes containing rhodopsin release Ca^{2+} in the light (Hubbell *et al.*), suggesting an intriguing future for such artificial systems. By fusing phospholipid vesicles preloaded with chelating agents to rod outer segments in intact retinas (Hagins and Yoshikami), it has been possible to introduce chelating agents into intact receptors, with results again consistent with the Ca^{2+} hypothesis. The hypothesis draws further support from intracellular recording during iontophoretic injection of Ca^{2+} chelators (Pinto *et al.*).

The second topic is retinal noise, the study of which originated some years ago with the realization that, close to threshold, the statistical fluctuations in absorbed photons must impart an equivalent fluctuation to the visual signals. The history of this topic is reviewed in the first chapter by Rose, who goes on to argue that one errs in believing that photon noise is only important close to threshold. (The historical review is flavored by passages from a 30-year-old referee's report by Selig Hecht recommending rejection of a manuscript by Rose.) Barlow points out that noise may also originate from a number of sources within the visual pathway—thermal isomerizations of visual pigment, sites at the receptor membrane, synapses, and even sites central to the retina. Retinal receptors of vertebrates (but not invertebrates) hold a surprise, for they can show greater noise in the dark than in the light. In turtle cones a suggested source of noise is the random closure of sodium gates, possibly due to fluctuations in the cytoplasmic

level of internal transmitter (Simon and Lamb). Thermal isomerizations would seem to require a higher Q_{10} than is observed. In turtle rods what appears as a similar fluctuation in membrane potential in the dark can be fractionated into two components on the basis of differences in power spectra; one component of noise is decreased by light, the other is decreased by hyperpolarization produced by intracellular injection of current (Schwartz). Viewed from this vantage point, the function of electrotonic coupling of receptors—a coupling that is surprising for cones, at least, because it would appear to degrade spatial acuity by increasing the size of the receptive field—may be to decrease receptor noise by averaging membrane responses over a population of cells.

Several authors have tried to estimate the amount by which the membrane potential of the receptor cell changes at threshold (Owen and Copenhagen, Fain, Schwartz), and the values range from less than 5 to about 30 microvolts. All of these estimates are several times smaller than the dark noise of the receptors, leaving open the question of how such small signals are reliably transmitted at the receptor-bipolar synapse. Part of the answer may lie in the low frequency response of the synapse (Baylor and Fettiplace), but one comes away from the book with the feeling that our current understanding of the relations between pre-synaptic voltage, Ca^{2+} entry, and transmitter release will prove inadequate for describing the behavior of the synapses between vertebrate photoreceptors and the retinal bipolar cells.

This description fails to convey the full extent of the book's coverage, for there are several additional chapters on the synaptic organization of the retina (Lassansky, Werblin, Toyoda *et al.*, Trifinov and Byzov). Other contributions include studies of the photo-induced conductance changes of outer-segment membranes (Fatt and Falk), an analysis of the retinal photocurrents (Arden), calculations of free energy changes in the bleaching of rhodopsin (Kropf), studies of membrane structure by x-ray and neutron diffraction (Blaurock), and a concluding chapter by Rushton entitled "How does your research explain our inability to see?" For readers interested in the early stages of vertebrate vision, this volume provides a number of views through the eyes of some of the most active of today's investigators.

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Environmental Role of Nitrogen-Fixing Blue-

(Continued on page 674)