evidence for the development of maize from teosinte and the rejection of a wild maize other than teosinte as the ancestral form.

South America, on the other hand, receives extensive coverage from Lathrap, MacNeish, Pickersgill and Heiser, Wing, and Cohen. Controversy follows Lathrap's imagined shipwrecked African fishermen who putatively brought the bottle gourd, cotton, and garden horticulture to Amazonia. According to Lathrap the dissemination of these plants to the Andes and Mesoamerica formed the basis of all subsequent domestication in the New World.

This source for American agriculture is rejected by other authorities. In this volume MacNeish details his recent research in Ayacucho, Peru. His conclusions are that climatic disequilibrium in an environment with habitat and seasonal diversity encouraged domestication independently in many localities. Clearly Wing's analysis of faunal evidence for llama and guinea pig domestication supports a local pattern of changing animal utilization and management. Most damaging to the Lathrap thesis is Pickersgill and Heiser's belief that the bottle gourd and cotton, admittedly with a genetic ancestry in Africa, were dispersed by natural agents other than humans and that the distribution of the progenitors of most domesticates in South America remains unknown. Finally, Pickersgill and Heiser regard the Andean root crop complex as a local derivation associated with other high-altitude crops and thus independent in origin from manioc and tropical tubers.

Aside from the dog and the turkey, indigenous domesticates north of Mexico were exclusively plants. Since Yarnell wrote his contribution to the volume, he has worked with evidence indicating that squash and gourd cultivars were introduced into the eastern United States from Mexico prior to the domestication of the native sumpweed and sunflower. In all, his presentation is an excellent statement of prehistoric relations between Indian populations and plants. The failure of Native Americans to domesticate animals is discussed without resolution by Carr.

The volume bears evidence of the difficulty of editing a work of such magnitude. An inverted map (p. 772) and a sideways photo (accompanying Vishnu-Mittre's paper, plate 4) are annoying, but several other errors are misleading for the nonspecialist: "metal template" (p. 342) should read "mental template"; the Indian Iron Age began in 1000 B.C. (not b.p.); 5 percent (not 55 percent) of the plants were cultivated forms by 7000 years ago in Tehuacán, Mexico; and the Balsas (not Batas) River possibly was the ancestral home of early teosinte-corn. These errors highlight a more serious problem. The scope of the book is so broad that no editor could determine the accuracy of each presentation. If the papers had been refereed by specialists, the unfortunate publication of questionable archeological "facts" might have been avoided.

Unlike the contributors, whose papers were completed in 1973, Reed wrote his summary chapter with the benefit of hindsight and more recent publications through 1976, and the reader is advised to read it in conjunction with individual essays. Unfortunately, by presenting a historical overview Reed missed an opportunity to relate major theoretical perspectives to data. In addition, although some of the papers are cross-referenced, the more controversial statements and disagreements of interpretation are not resolved and are often left unacknowledged in his summary.

Origins of Agriculture is an excellent reference. The theoretical ideas are poignant, the regional syntheses are invaluable, and the book is an exceptional testament to the accomplishments of truly interdisciplinary research. It is evident that in the past century the stages of domestication of major plants and animals have been discovered, but why agriculture began and how it spread are matters for continuing investigation.

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Ecology of Tropical Trees

Tropical Trees as Living Systems. Proceedings of a symposium, Petersham, Mass., Apr. 1976. P. B. TOMLINSON and MARTIN H. ZIMMERMAN, Eds. Cambridge University Press, New York, 1978. xviii, 676 pp., illus. $49.95.

The contemporary ecological knowledge about tropical trees presented in this book resembles the tropical rain forest itself: there are gaps, fast-growing components, and occasional tangles.

The book, the proceedings of a symposium held at Harvard Forest, deals with the individual tree as an integrated living system and with its interaction with other trees in tropical vegetation. The 28 contributors were chosen with the aim of crossing the unnatural and unnecessary barriers that often divide the biologists of temperate and tropical countries. The result is an authoritative synthesis of our understanding of the organization and growth of trees in the tropics, with some useful guidelines for future research. Unevenness in treatment is inevitable in such a collection, but it is no longer possible for any one author to encompass such a wide and changing field—the efforts of Richards, Walter, Whitmore, and others to do so notwithstanding.

The book covers a variety of interconnected subjects: origins and variation, reproduction and demography, architecture and construction, morphology, organizational control, and community interactions. The tropical tree is consequently viewed in many ways—for instance, as a photosynthetic device consisting of assimilating units (leaves) arranged on one or more woody, self-supporting axes and as the smallest segment in a mosaic of successional stages. Well-edited discussions follow each paper.

The perspectives of continuing research projects are always borne in mind, so that the reader gains a picture of research trajectories ranging from root to seed and from simple to sophisticated. Thus Tatuo Kira offers a brilliantly concise summary of integrated ecosystem research done as part of the International Biological Program in 1970–74 at Pasoh Forest, West Malaysia, which deals specifically with the dynamics of organic matter.

F. S. P. Ng discusses the strategies of tree establishment and the longevity of seeds, reaching the somewhat surprising conclusion that dormancy is not particularly characteristic of pioneer or nomad species in the humid tropics. The mainstream of evolution has favored large seeds and seedlings with rapid and epigeal germination, so that in dense humid forests efficiency in dispersal and efficiency in species survival are two different things.

P. S. Ashton points out that, despite the alarming rate of expansion of secondary forests in the tropics, very little quantitative work on woody seral succession is being done. He then details some simple observational studies of crown characteristics at pioneer, building, and mature stages that show the adaptive significance of architectural models. There is in fact much preoccupation in the book with architecture and construction, and the stage is set by a lucid description by P. B. Tomlinson of

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 counterproductive 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 disappointingly 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