recently reprinted *A History of Entomology*, which deals only with American entomology, there is nothing else currently in print which deals at all extensively with its subject matter. The price being reasonable, many individual entomologists, as well as libraries, should find it a worthwhile buy.

R. A. CROWSON
Zoology Department, University of Glasgow, Glasgow, Scotland

Botanical Symbiosis

Ectomycorrhizae. Their Ecology and Physiology. G. C. MARKS and T. T. KOZLOWSKI, Eds. Academic Press, New York, 1973. xvi, 444 pp., illus. $28.50. Physiological Ecology.

This book is a collection of papers concerned with the ecology of mycorrhizae. The authors interpret "ecology" very broadly, as is useful in view of the fact that the morphology, chemical composition, physiology, genetics, geographical distribution, and classification of mycorrhizae are not well enough known to provide an adequate foundation for the study of their ecology. Structure and morphogenesis are discussed by Marks and Foster, classification by Zak, distribution in forests by F. H. Meyer, growth of ectomycorrhizal fungi around seeds and roots by Bowen and Theodorou, mineral nutrition by Bowen, carbohydrate physiology by Hacskaylo, hormonal relationships in mycorrhizal development by Slankis, the rhizosphere of mycorrhizae by Rambelli, mycorrhizae and feeder root diseases by Marx, and applications in forestry by Mikola. The authors are currently publishing on mycorrhizae so their work has already been critically considered. They take some pains to review the literature, and in this they are aided by the publication within the last decade of at least nine symposia or texts on mycorrhizae.

A real difficulty in many studies of mycorrhizae is lack of identification of the fungi involved. Although this book contains author and subject indexes, it lacks an index to species. Successful application in forestry practice, such as the Austrian planting of *Pinus cembra* in timberline situations for avalanche control, has been much aided by Moser's careful mycological work.

The individual papers are careful, thoughtful presentations. Meyer's covers the widest intellectual range. Bowen brings in many ideas from the field of plant nutrition and attempts to make his discussion rigorous. Classification, as noted above, is simply unsatisfactory, a situation that certainly is no fault of Zak's. Slankis extends and defends the very interesting pioneering work he began long ago. The other papers illustrate nicely the extreme complexity of the subject and the many ways in which it cuts across conventional lines between plant-oriented disciplines. Could this latter account for the small representation of university researchers among the contributors?

Considerable emphasis is on forestry aspects of mycorrhizal problems, and this is no fault. Possibilities of application keep research and conclusions reasonable and testable. The heavy emphasis on a few tree species is disadvantageous, however, if mycorrhizal investigators allow themselves to be confined by their experimental material as plant physiologists have done with a very limited repertoire of crop plants. Mycorrhizae are of wide occurrence in natural vegetation, and noneconomic plants may be excellent experimental material. The investigators represented here are well aware of the importance of competition between plants, so their physiology is not automatically inapplicable, and they fulfill their aim of elucidating the ecology of mycorrhizae.

JACK MAJOR
Botany Department, University of California, Davis

Subunit Associations

Protein-Protein Interactions. Proceedings of a colloquium, Mosbach, Germany, Apr. 1972. R. JAENICKE and E. HELMREICH, Eds. Springer-Verlag, New York, 1972. viii, 464 pp., illus. $24.80.

This volume is the proceedings of a meeting that attempted to present an overview of molecular interactions in protein molecules. Out of this broad area of research, the colloquium concentrated on the functional advantages of multisubunit structures, with the emphasis on the nature of quaternary structure. The self-assembly and symmetry of these biological "supramolecular assemblies" are presented as a natural prerequisite for the development of diverse cooperative effects that are utilized in oligomeric proteins. These interactions often endow oligomers with increased stability or functional capability, improved efficiency, and the possibility for the control mechanisms essential for complex biological systems. Understanding the way such cooperative effects are mediated through intra- and intermolecular subunit contacts is of central importance in biology.

The symposium consisted of 20 invited papers which illustrate the diversity of solutions that nature has evolved to meet her needs in the hierarchy of molecular organization. The importance of quaternary structure in proteins is represented by the relatively simple tetrameric hemoglobin molecule, which remains a standard in the understanding of biological function on chemical and physical principles. The emphasis here and throughout is on the nature of the subunit associations and the resultant cooperative effects. Aspartate transcarbamylase, which consists of 12 polypeptide chains, is presented as one example of organization of a regulatory enzyme that uses separate catalytic and regulatory chains. Multienzyme complexes are one example of heterologous protein interactions. Besides profiting from quaternary structure in all ways accessible to monofunctional oligomers, multienzyme complexes have an additional inherent advantage of spatial organization for promoting efficiency of catalysis. Tryptophan synthetase is a small multienzyme complex which may be regarded as a dimer, $\alpha_2\beta_2$, of functional $\alpha\beta$ dimers. Although the individual subunits α and β_2 have distinct catalytic functions, the formation of the $\alpha_2\beta_2$ complex leads to large increases in the catalytic efficiencies of the partial reactions. Evidence is presented to indicate the formation of a composite active site where the preexisting sites in the α and β_2 subunits are brought into direct contact. Other topics include the protein assemblies in muscle, antigen-antibody interactions, the self-assembly of viruses, and the relevance of cell-cell interactions. In addition, there are papers on the nature of molecular forces involved in protein-protein interactions and on the importance of self-assembly and symmetry, and repeated examples of how experimental techniques of electron microscopy, x-ray diffraction, chemical and spectral probes, and others have been combined to elucidate the properties of complex biological systems to make a colloquium of this sort possible.

The book presents a broad yet cohesive summary of the recent developments in this area. The numerous high-quality figures and the inclusion of discussions enhance its value. Most of the