cover a wide variety of topics related to the use of nitrogen by plants.

Traditional genetics and plant breeding have seldom been applied to increasing symbiotic N_2 fixation. Two papers by G. H. Heichel and D. K. Barnes and their co-workers decribe and evaluate a breeding program to enhance fixation by alfalfa. These scientists demonstrated that genetic differences for fixation do exist in alfalfa lines. Plant traits, including nodule mass, shoot dry weight, and fibrous roots, were positively correlated with nitrogen-fixing ability. Though it is obvious that many plant genes are involved in the symbiosis, significant increases in fixation were achieved after only a few generations of selection. It was important to test selections in the field, with appropriate rhizobial inoculant. This research demonstrates the potential for increasing N_2 fixation in agriculture. The authors recommend a similar collaboration of breeders, microbiologists, and plant physiologists for each major legume crop.

Symbiotic fixation is not "free fertilizer," and several papers deal with the energetics of N_2 fixation. There is some evidence that symbiotic fixation by legumes requires more energy than utilization of soil nitrate. It has been difficult till now, however, to estimate the metabolic cost of nodule formation and maintenance, or the cost of *p*H control during assimilation of nitrate. D. K. McDermitt and R. S. Loomis propose a novel method of determining, on the basis of the elemental composition of a legume and its growth yield, the cost of growth on different nitrogen sources.

The nitrogen-fixing enzyme nitrogenase reduces protons to H_2. This contributes to the energy cost of fixation if H_2 escapes the nodule. Some strains of *Rhizobium* have an uptake hydrogenase (Hup), which may permit a partial recovery of the energy lost in H_2 formation. A survey of soybean nodules from every soybean-producing area in the United States indicated that 75 percent were infected by rhizobial strains lacking the enzyme (Hup^-). It is remarkable that the *R. japonicum* strains in most commercial inoculants for soybean are similarly Hup^-. The gene for Hup is carried on a rhizobial plasmid, so it should eventually be possible to incorporate hydrogen uptake activity into efficient strains adapted for each region.

Denitrification is the process whereby some soil bacteria convert nitrate to N_2 or volatile nitrogen oxides. Up to one half of added nitrate fertilizer may be lost to the atmosphere in this way. Many of the bacterial species involved do not grow well in vitro, and the assays for some enzymes are difficult. Only a handful of scientists have persisted in studying this subject. Despite the major role of denitrification in decreasing soil fertility, the study of it is generally underfunded and unrecognized. For the nonspecialist, the 100 pages here provide a very good introduction to the topic.

Much of the research presented in the book has appeared in journals. Most of the papers are too short to adequately review their topics. Of little value as a reference book, this work may inform the casual browser.

T. LaRue
Boyce Thompson Institute for Plant Research, Ithaca, New York 14853

Paleobotany

Geobotany II. Proceedings of a conference, Bowling Green, Ohio, March 1980. Robert C. Romans, Ed. Plenum, New York, 1981. viii, 264 pp., illus. $39.50.

Geobotany II includes papers presented at the 1980 geobotany conference. (An earlier conference yielded *Geobotany.*) It includes all the papers presented, except for those by M. B. Davis, J. A. Doyle, and A. H. Knoll, for which only abstracts are included. (Doyle and Davis have presented similar ideas elsewhere, but Knoll's abstract on the paleoecology of Pre-Cambrian "microbes" is a bit frustrating—one would like much more. What business has an abstract—by nature an evanescent thing—in a book?)

The papers are mostly in the general area of paleobotany-paleopalynology. There is one ecological study (R. W. Dexter) of plant succession of a disturbed area at Cape Ann, Massachusetts, which really does seem out of place next to papers on the cupule organization of the earliest seed plants (L. C. Matten and W. S. Lacey) and the anatomy of two Paleogene woods (W. H. Blackwell *et al.*), though not so far out of line with a study of environmental changes in time, shown by "peat petrology" in South Florida (P. R. Kremer and W. Spackman), and one on the postglacial history of prairie fens and bog fens in Ohio (R. L. Stuckey and G. L. Denny). A number of the papers are pollen-analysis–based studies of Pleistocene and Holocene sections in various parts of North America (papers by R. E. Bailey and P. J. Ahearn; J. Terasmae; J. F. P. Cotter and G. H. Crowl; W. J. Merry; P. A. Delcourt and H. R. Delcourt). These are conventional pollen-analysis studies, but an editorial novelty is introduced in the papers by Cotter and Crowl and Bailey and Ahearn: foldout diagrams, as well as the *same* diagrams in page size, with a note that a full-size diagram follows. Surely no journal editor would have allowed that.

The two papers that were most interesting to me were those of G. R. Upchurch, Jr., and J. A. Doyle on the paleoecology of two Cretaceous conifers, *Frenelopsis* and *Pseudofrenelopsis*, that produced *Corollina* (*Classopollis*) pollen, showing that the two conifer genera had quite different ecological requirements; and a fascinating series of seven vegetation maps, 40,000 years ago to present, by Delcourt and Delcourt, based on paleobotanical-paleopalynological data. Unfortunately the maps, though very useful, are flawed and frustrating, because the shading on them is at a different scale from those in the keys and in a couple of cases even of a different pattern. I have colored mine with crayons as an aid but am still not sure I have it right. Again, a journal editor and referees would have caught this sort of thing. There are other difficulties, for example, unexplained boundary lines on maps in Stuckey and Denny. A final reason why these papers should have been submitted to ordinary journals is that there is buried on p. 213 the description by Blackwell *et al.* of a new genus (*Floroxylon*) not even mentioned in the abstract. Publication of new names in unconventional places is not uncommon but is a nomenclatural nightmare to be avoided.

Alfred Traverse
Department of Geosciences, Pennsylvania State University, University Park 16802

Peat Bogs

Peat Stratigraphy and Climatic Change. A Palaeoecological Test of the Theory of Cyclic Peat Bog Regeneration. K. E. Barber. Balkema, Rotterdam, 1981 (U.S. distributor, Merrimack Book Service, Salem, N.H.). xii, 220 pp., illus., + plates. $29.

A long-prevailing explanation for the upward growth of raised bogs involves cyclic hummock-hollow regeneration: hollows between hummocks are characterized by rapid growth of *Sphagnum* species, whereas the dry hummocks are relatively dormant; hollows thus become hummocks, and the microtopography is reversed cyclically many times as the peat accumulates. This book, an outgrowth of a University of Lancaster dis-