opment, the funding of long-term projects is often unpopular at land-grant universities and federal agencies.

There is general agreement that wetland functions are closely related to wetland hydrology, but this subject has largely been left to biologists by default. It is refreshing, therefore, to read the contributions of the few wetland hydrologists around. Carter, Bedinger, Novitzki, and Wilen review the flood storage capacity of different wetland types, considering water budgets and vegetation. To control flooding by the Charles River it was found to be more economical to purchase the existing wetlands than to establish a network of dams. Wisconsin peatlands also reduce flooding but deplete rather than sustain streamflow during summer drought.

Odum and Lugo and Brinson discuss the many difficulties in evaluating the "public" services of wetlands by means of an economic system that most effectively measures short-term, private, and selfish interests. Odum asks who is to use the wetlands and when. Lugo and Brinson flatly reject the premise that a value system based on accepted economic theory can address the physical and evolutionary reality of ecosystem dynamics. The discussion that followed their paper at the meeting is unfortunately not included here.

Perhaps there will be a second volume that will discuss more thoroughly other aspects of wetland ecosystems such as the microbiology of flooded soil, the many non-American publications on wetlands, and the usefulness of an experimental approach. Those involved in wetland management and ecology will find the present volume very useful.

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## Plants under Stress

**Adaptation of Plants to Water and High Temperature Stress.** Proceedings of a Seminar, Stanford, Calif., Nov. 1978. NEIL C. TURNER and PAUL J. KRAMER, Eds. Wiley-Interscience, New York, 1980. xiv, 482 pp., illus. $40.

The global distribution and abundance of terrestrial plant species are determined to a large extent by the availability of water. Tropical rain forests are among the most diverse and productive of terrestrial ecosystems, whereas arid and semiarid regions show low diversity and low annual productivity. Environments with low annual precipitation are usually environments of high irradiance and frequently those that experience high temperatures during a significant portion of the year. Therefore, water stress and high-temperature stress are often encountered together in natural as well as in agronomic situations. The volume under review addresses the responses of both native and economically important plant species to these environmental factors. The volume contains 28 papers by an impressive international group of over 50 plant scientists representing such fields as plant physiology, agronomy, agricultural engineering, ecology, and forestry. The papers are not purely descriptive but attempt to characterize the long-term adaptation and short-term acclimation of plants to temperature and water stress.

The volume includes treatments of such topics as morphological and physiological responses to stress. It is evident that plant leaves show the greatest plasticity in response to water stress, though modifications in root structure and size are also seen. The responses of stomates to tissue water deficits and to evaporative demand are shown to be highly adaptive. Many species are capable of adjusting to regular water-deficit regimes by keeping stomates open at lower leaf water potentials, allowing for continued carbon dioxide exchange for photosynthesis. The influence of water stress on photosynthesis, however, extends beyond stomatal control. Fairly dramatic effects of tissue water deficits are expressed on chloroplast function at the biochemical and molecular levels. Though this topic is treated along with other metabolic consequences of water and temperature stress, it is clear at the outset that our knowledge of the molecular features of plant response to stress is meager.

Consideration is also given to long-term and seasonal integrated responses of native and agricultural communities to water and temperature stress. These types of studies, in conjunction with those summarized earlier in the volume, are providing the data bases for modeling efforts. In a paper by H. G. Jones, a stochastic model for plant response to water stress is developed. Though such activities are in an early stage of development, they demonstrate the potential for realistic predictive modeling of integrated plant responses to the environment as a means of evaluating productivity potential. The final section of the volume is devoted to the prospects of breeding plants better able to adapt to short- and long-term temperature and water stress.

The volume is well organized and illustrated, but it suffers from a problem common to this area of research: the lack of acceptable definitions and consistent usage of the terms "adaptation," "stress," and "acclimation." Kramer's introductory paper is devoted to this topic, and the problem is well illustrated in the book, since the contributors assume their own definitions and usage, making comparisons between some chapters difficult. Though the volume emphasizes plant responses to stress and their possible adaptive significance, it neglects treatments of mechanisms of stress perception and recovery from stress. Despite this shortcoming, many different and valuable perspectives on plant stress are successfully brought together, and the book provides important directives for future research. It should find its way to the bookshelves of a broad range of plant scientists.

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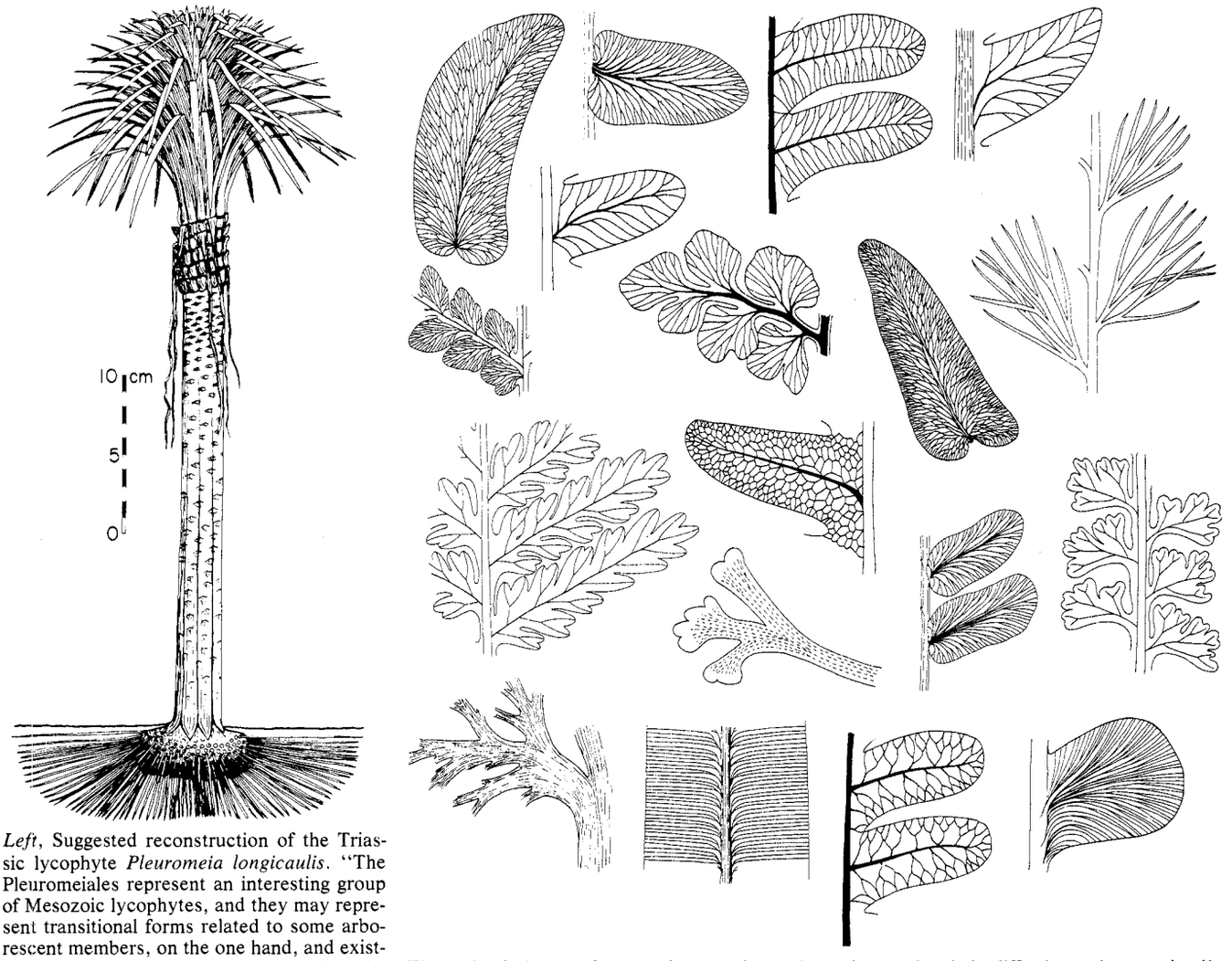
## Paleobotany Surveyed

**Paleobotany.** An Introduction to Fossil Plant Biology. THOMAS N. TAYLOR. McGraw-Hill, New York, 1981. xvi, 590 pp., illus. $29.95.

This is the first textbook of paleobotany to be published in the English-speaking realm for more than a decade. The last one (Banks's *Evolution and Plants of the Past*, 1970) was a short overview of some major topics. The last textbooks comparable in size to Taylor's were Darrah's *Textbook of Paleobotany* and Andrews's *Studies in Paleobotany*, published in 1960 and 1961 respectively. This long gap is astonishing in view of the rapid progress that has been made in paleobotany over the last 20 years and the many major problems that have been elucidated during that time. It seems as if the rapid rate of paleobotanical discovery kept authors so much in suspense that they did not dare to attempt a comprehensive textbook. The lack of an extensive recent treatment of paleobotany has been felt not only in the classroom but also by those in other fields who wanted a summary of modern advances in paleobotany. Taylor's book fills both needs admirably.

The book is written in a readable style. The chapter arrangement is according to systematic group, with interspersed chapters dealing with major general topics—the early evolution of land plants




*Left*, Suggested reconstruction of the Triassic lycophyte *Pleuromeia longicaulis*. "The Pleuromeiales represent an interesting group of Mesozoic lycophytes, and they may represent transitional forms related to some arborescent members, on the one hand, and existing lycophytes such as *Isoetes*, on the other. The order is known from so few species and specimens that it is difficult to characterize." [Reproduced in *Paleobotany* from G. J. Retallack, *Alcheringa* **1**, 3–29 (1975)]. *Right*, Paleozoic foliage. "Probably the most widespread and conspicuous plant fossils of the Carboniferous are the . . . remains of fernlike foliage. The presence of what was thought to represent a diverse flora resulted in the Carboniferous being referred to as the Age of Ferns. However, this designation was applied before it was known that some of the fernlike foliage was produced by seed plants. . . . Nowhere is the species problem more complex in paleobotany than in dealing with fern foliage types, where many of the 'species' undoubtedly represent foliage or simply the variation inherent in a biological species from different parts of the frond at different stages of development. Despite these limitations, . . . foliage types have been used successfully in subdividing portions of the Carboniferous into recognizable divisions of geologic time." [From *Paleobotany*]

and evolution of the seed habit. The treatment is complete and includes the rarely preserved groups (bacteria, fungi, lichens, bryophytes), which are nevertheless significant for general conclusions about life and paleoecology through geologic time. The balance in subject matter the author attempted has certainly been achieved. The extent of treatment of the major groups is equivalent to their importance through geologic time and the duration of their existence on earth (lower vascular plants receive 39 percent of the pages, gymnosperms 34 percent, angiosperms 8 percent).

Throughout the book the evolution of individual groups, and not the floristic changes through time, is stressed. The discussion of each group is quite detailed and includes all the major hypotheses and theories, even those that are not accepted by the vast majority of paleobotanists. The accounts of all theories and findings are very carefully worded. This will help readers to keep their critical distance and make it easier to foster a critical attitude in students.

Paleobotany is of interest to both biologists and geologists. Taylor takes this into consideration by giving basic biological and geological information—for instance, he gives a lucid introduction to vascular plant structure and includes an extensive geologic time table in an appendix. Unfortunately, the correlation of the Mississippian-Pennsylvanian boundary with the European chronostratigraphy is two stages off (placed at the Namurian-Westphalian instead of at the Namurian A–Namurian B boundary). That is the only error I encountered in the book.

The book is very well illustrated, as is essential to a good paleobotany textbook. Portraits of well-known paleobotanists are interspersed with illustrations of the material they worked on. This will be helpful to students to get a feeling for the individuals behind significant discoveries and for the historical continuity of paleobotany.

Taylor's *Paleobotany* not only gives an excellent survey of the recent progress and established knowledge of paleobotany but also transmits its fascination and excitement. It points out many promising areas of inquiry and will help to train the next generation of paleobotanists, biologists, and geologists.

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