

This treatment initiates formation of abscission zones that, in turn, loosen the fruits. Harvest then becomes a simple process of agitation—either shaking of the stem or a blast of air, followed by collection of the detached fruits. Ethylene-aided mechanical harvesting is a common procedure for cherries, blueberries, grapes, and oranges.

Sometimes, fruit abscission needs to be prevented. For example, when grapefruits and oranges reach maturity, they naturally drop from the tree as a result of abscission. To prevent this process and its associated economic losses, trees can be sprayed with auxin or with a mixture of auxin and GA when the fruits are quite young. The combination of the two hormones accomplishes two purposes: auxin keeps mature fruits on the tree, GA keeps them fresh.

Once a fruit has been harvested, senescence proceeds rapidly. (Senescence also occurs when flowers are removed.) To prevent this, fruits are usually stored at low temperatures to slow down their metabolism, and they are kept in a controlled atmosphere. Often, the amount of carbon dioxide in the air is artificially increased in storage because carbon dioxide tends to counteract ethylene's stimulatory effect on senescence, through a mechanism called "competitive inhibition."

Promising Areas for Applications Research

Other strategies currently are being used to control plants with phytohormones, but the examples given here illustrate the major strategies in use. Much already has been accomplished, with considerable economic impact, but much more could be done if the appropriate technology were developed.

For instance, it is conceivable that a plant's own defense systems for preventing diseases caused by viruses and microorganisms could be accentuated with chemicals. One class of compounds responsible for disease resistance (phytoalexins) has already been identified, and research currently is under way on phytohormones

to stimulate the production of phytoalexins. If this research succeeds, we might be able to improve a plant's response to disease through the use of chemicals.

A second promising area involves so-called "bioregulators," which are chemicals that stimulate plants to make valuable products. For example, ethephon is used commercially to increase the production of rubber by *Hevea*. Another group of bioregulators is now being evaluated for their effects on the production of terpenoids by plants.

Of course, the greatest potential impact of phytohormones involves "biotechnology," the concerted application of different scientific disciplines to plant genetics. While most accounts of biotechnology emphasize the contribution of DNA biochemistry, biotechnology would not be feasible without the use of phytohormones, especially of cytokinin, to produce whole plants with new characteristics starting from single, genetically altered cells. Even today, phytohormones play a crucial role when tissue culture is used for the rapid, clonal propagation of plants that have superior characteristics, and for the production of plants, such as strawberries, that are free of virus and fungal infections.

Tissue culture, in spite of its performance, is still a relatively new technique. The common method for micropropagation takes advantage of the established role of cytokinin as a shoot-growth regulator and of the fact that shoot explants from many species can be grown on a medium consisting of basal nutrients plus cytokinin. During the last few years at the Arnold Arboretum, research has been conducted to determine whether this same method can be applied to woody plants in general. While this research is still under way, it has already made clear that micropropagation would be feasible with several groups of woody plants that are not now being exploited. For example, nearly half of the thirty-five families studied to date respond to cytokinin treatments in tissue cultures even though current micropropagation work with woody plants focuses on only two families—the

Rosaceae and the Ericaceae. On the other hand, it is also apparent that this technology will not work for all woody species. Obviously, we do not fully understand shoot growth in several species.

Before cytokinin was known, micropropagation of plants was not possible. Nonetheless, basic research on the internal control of shoot growth led not only to the discovery of cytokinin, but to a new and important practical use for phytohormones. Looking to the future, but reflecting also on fifty years of successful work with chemicals that regulate plants, we can feel almost certain that similar successes will occur. As we learn about phytohormones and discover new kinds, our ability to regulate plants will also increase. As so often happens, botany and horticulture will complement each other.

John W. Einset, a staff member of the Arnold Arboretum, is associate professor of biology in Harvard University. His article on biotechnology at the Arnold Arboretum appeared in the Summer 1984 issue of Arnoldia. With the present article Professor Einset inaugurates a new column for Arnoldia. Called "Botany: The State of the Art," the column will deal with practical application of botanical research to horticulture.

BOOKS

Garden Design: History, Principles, Elements, Practice, by William Lake Douglas, Susan R. Frey, Norman K. Johnson, Susan Littlefield, and Michael Van Valkenburgh. Derek Fell, principal photographer. New York: John Wiley and Sons, 1984. 224 pages. \$35.00.

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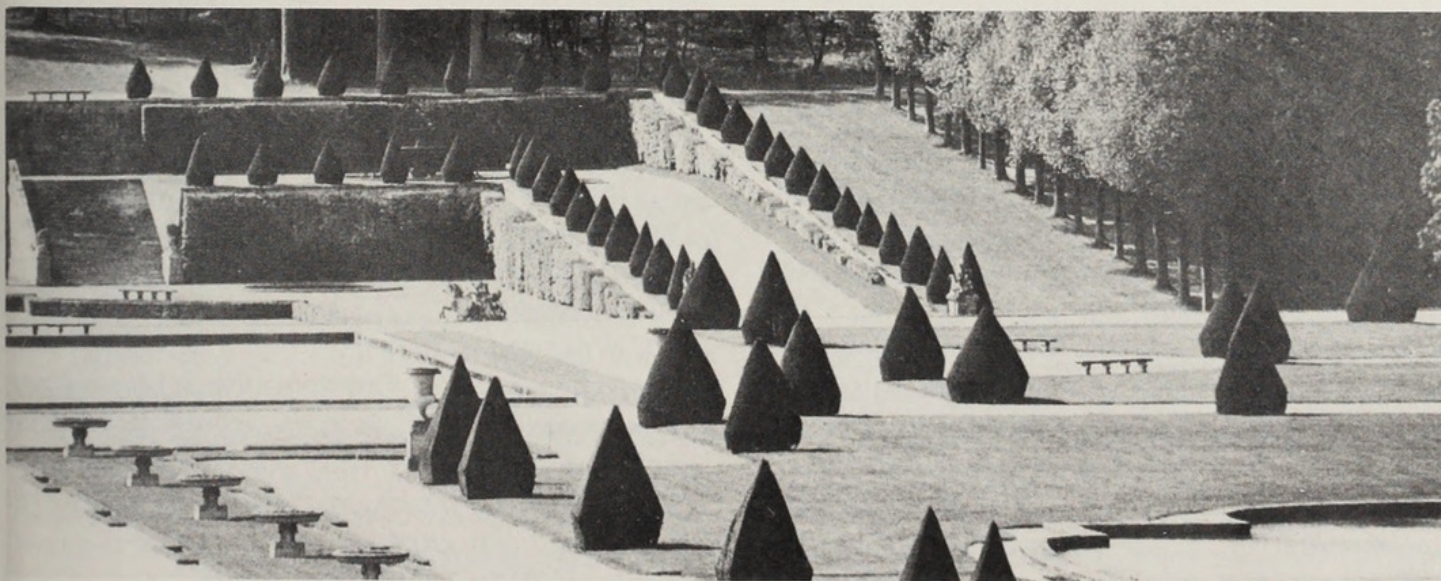
This multiple-author book on garden design is introduced by John Brookes, as well-known landscape designer and garden writer from Britain. Brookes observes that we "dream up a garden to escape the rigors of our society," and, whether or not escapism is the reason people garden, it seems true that gardeners are dreamers. When the earth is frozen and winter snows end the growing season, the serious gardener simply turns to his plant books and catalogs and dreams his visions of the greater glories of the next year. He reads, plans,

The gardens at Vaux-le-Vicomte, France, considered one of the greatest achievements in the French landscape style. It was designed by André le Nôtre in the seventeenth century. Photograph by Christopher Little. Used with the permission of Quarto Marketing, Ltd.

and anticipates until he can dig in the soil again. *Garden Design* will enrich winter dreaming.

A group of garden designers and writers put this book together in cooperation with the Publication Board of the American Society of Landscape Architects. Hundreds of color photographs, many of them the work of talented garden photographer Derek Fell, illustrate various garden styles ("The Parterre," "The Outdoor Room," "The Country Cottage," "The Oriental Style," and "The Wild Garden") and the varieties of built elements and embellishments that can be used to implement those styles (paving, turf and ground covers, gates and windows, and so on). From its dust jacket to the final photographs, this book is a rich source of ideas.

The first of *Garden Design's* six chapters is a concise review of garden history. It gives the novice an organized and clearly written overview but will not disappoint the more knowledgeable garden-history reader. The latter will appreciate the author's balanced assessment of landscape gardening. Proper emphasis is given to the enormous impact of nineteenth-century plant collecting on garden design. The author (William Lake Douglas) succeeds in conveying to the reader the vitality and energy of the Victorian who tended his garden during the period when America's



newly emerged middle class was embracing the idea of conscious garden design. Appropriate attention is also given to Andrew Jackson Downing's important role in American landscape design. Downing's widely popular books were the first publications in this country to emphasize garden design based on aesthetic principles and the concept of unity of house and grounds.

The essence of the three major chapters of the book ("Discovering Your Style," "A Sense of Place," and "Elements of the Garden") is simply stated: determine what you want in your garden and adapt it to the space you own by using the appropriate design elements. This is, needless to say, not so easily accomplished, and *Garden Design* will not take the place of professional help, nor will it guide the do-it-yourself gardener through the planning and installation process. However, instructions of creative design ideas accompanied by intelligent and precise captions can help the gardener take the first step toward understanding some general design principles and defining his own personal tastes. This book offers that kind of help in abundance.

Chapter Five, a showcase for the work of fifteen garden designers from the United States and four other countries, is a combination of text and photographs. Both the reader and the designers whose work is dealt with might have been better served if the two pages allotted to each designer had been devoted exclusively to photographs of his work, along with carefully crafted captions telling the reader what the designer's intention was and how he achieved the effects he sought through his choice of design elements. As it is, the two pages are a mixture of biography, direct quotes, and the author's assessment of the designer's work. Photographs allow a reader to see, and judge, for himself.

The last chapter, entitled "Garden Wisdom," is said to be a "necessary reference on all aspects of implementing the garden's plan," but it is much too short to be a useful reference. It does, however, impart some marvelous bits of advice that are essential to successful gardening. Take the first sentence of the last chapter, for instance:

"The better part of garden wisdom has to do with patience. You simply cannot make a garden in a hurry." Garden dreamers understand patience. They will also understand and appreciate the rich ideas in *Garden Design*.

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Plants that Merit Attention: Volume I—Trees, edited by Janet M. Poor. Portland, Oregon: Timber Press, 1984. 352 pages, 429 color plates. \$44.95.

RAY ANGELO

Most illustrated tree manuals are guides to the identification of the trees that grow in a given geographic area. This handsome volume is different. It brings to the fore a number of neglected species, varieties, and hybrids of trees that would be worthy additions to parks and gardens, offering a generous selection of 143 taxa. Most of the taxa it treats originated in eastern Asia (60 taxa), North America (47 taxa), or the Europe-Mediterranean area (17 taxa). This selection reflects the target area for the manual, which is North America. Their visual appeal, seasonal interest, and tolerance of one or more environmental stresses were the bases for including taxa that are not often seen in horticultural landscapes.

This book will be a useful aid in selecting appropriate species and varieties of trees for given sites in yards, gardens, and parks. To consult it is to opt for novelty. The geographic location of a site will immediately eliminate a number of taxa from consideration. One appendix in this volume groups species and varieties according to their cold-hardiness. Only *Larix decidua* is hardy in USDA Zone 2 (northern Quebec, northern Ontario, etc.), for example, while ten species are hardy in Zone 3 (northern Minnesota, northern

Maine, etc.). Additional appendixes list the species that do best in sites with special soil-moisture conditions (moist to wet, arid, seacoast) or shade. Still other appendixes list the species that are more or less tolerant of environmental stress and those that are resistant to pests and diseases (although the reader must refer to the text to find out *which* stresses, pests, and diseases).

Once the limitations of a site have been dealt with, the subjective preferences of the reader will narrow the choice further. Appendixes listing species on the basis of flower color, fragrance, conspicuous autumn foliage, and whether they are deciduous, coniferous, or broad-leaved evergreen will assist the reader who seeks a particular quality in the candidate tree.

At this point the reader will want to consult the body of the book, where entries are arranged alphabetically by scientific name. The color photographs are, perhaps, the most striking feature of the book, which as a whole is of a high quality. Albert W. Bussewitz, whose photographic and interpretive work at the Arnold Arboretum is well-known, contributed many excellent photographs. Of particular note for their beauty are his close-ups of *Asimina triloba*, *Davidia involucrata*, *Halesia monticola*, and *Sciadopitys verticillata*. Although in most instances the three photographs provided for each taxon show its habit and distinctive attractions, the same feature is occasionally illustrated more than once (for example, *Gordonia lasianthus*, *Ilex* spp., *Oxydendrum arboreum*, and *Tabebuia chrysotricha*). For some taxa there is no close-up one could use to discern their distinguishing features (for example, *Prunus* 'Okame'). The photographs alone may be enough for making a final choice, but, if not, the text is available.

Many botanists, horticulturists, and nurserymen contributed to the text, among them Stephen A. Spongberg and Gary L. Koller of the Arnold Arboretum staff. Since this is not an identification manual, keys to species are not provided or appropriate. Comparisons with closely related species are almost entirely with reference

to their landscape value. The text is divided into three categories for each entry: description, culture, and landscape value.

The descriptive material is not intended to separate the included species from related species, which would be done routinely in a taxonomic work, but rather to highlight features of interest and to provide basic information about each taxon: its size, habit, leaf size, fall color, flower color and size, fruit character and size, and bark aspect. An illustrated glossary in the Introduction defines botanical terms, most of which are used in the text. Terms relating to ovary position are not used in the flower descriptions, however, while other terms, such as "rotate," "globose," "glaucescent," and "stomata," are used in the text but not defined.

The section on culture gives more details about soil, light, and moisture requirements and on disease and insect problems that are merely touched on in the appendixes. This section also provides notes on transplanting and propagation that may require elaboration from a nurseryman once a tree has been chosen. For example, the note on transplanting *Sapium sebiferum* is simply, "Easy when young."

If at this point the reader is still weighing evidence before making a decision, the landscape-value paragraph might suffice to tip the balance. This portion of the entry certainly makes the most interesting reading. Noteworthy facts about the species (for example, *Prunus subhirtella* 'Autumnalis'—"One of the earliest Oriental cherries to bloom"), comparison with related species, and practical or historical notes (*Michelia doltsopa*—"A valuable timber tree in the Himalayas"; *Roystonea regia*—"Named for General Roy Stone") make up this section.

As a last resort, one might have to examine a living specimen before making up one's mind. To this end, the entry for each species includes a list of the arboreta, botanical gardens, and notable parks and gardens where one could observe the species. Useful as such a list is, many readers will find it impractical to visit most of the worthy institutions listed. In particular, the list could



1985. "Books." *Arnoldia* 45(2), 35–39.

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