having the indusia set back from the margin about 2 to 3 times the length of the indusium, the vein ends are also far from the margin.

M. strigosa forma *MacFaddeniae* Morton (sometimes misapplied to *Nephrolepis Duffi, Lindsaea cultrata*). A small fern with very narrow fronds, the pinnae so condensed as to have imbricated fan-shaped segments, the lower pinnae often less condensed and much longer than those above. Origin unknown. Semi-hardy. To 1 ft. tall. Evergreen. Shade.

Cultivated ferns superficially similar to microlepias include the dennstaedtias, and possibly some of the athyriums or Lady ferns. Of these, microlepias are the commonest in southern California cultivation. Dennstaedtias are sparingly cultivated and can be distinguished by the cup-like indusium borne at the very edge of the frond, while athyriums have chaffy or broad scales along their stipes and never any hairs.

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The Aesthetic and Recreational Values in Botanic Gardens

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A Thesis submitted in partial satisfaction of the requirements for the degree of Master of Landscape Architecture, College of Environmental Design, in the Graduate Division of the University of California. This is a young landscape architect's views on the values of botanic gardens (and could well have included arboreta) to modern day living. We felt that this thesis has much to offer the lay plantsman in history, development and uses of botanical institutions starting, as Miss Morel has, with the Royal Garden of Thotmes III in 1500 B.C. She has complied her data from some 120 authors, bringing together, in a single paper, a rich source of information on a subject of interest to all of us. Because of the length of the paper, we shall print it in Lasca Leaves as a continuing feature for several issues. Ed.

CHAPTER I

PATTERN FOR A STUDY OF BOTANIC GARDENS

An investigation of botanic gardens and arboreta offers many areas for study, emphasis, and consideration. An adequate treatment of the comprehensive topic would require many volumes, and a much more extensive work than is undertaken here. In this necessarily brief study, attention is to be given to certain limited evolutions of purpose as these are identified and implemented in outstanding botanic gardens, over a period of many centuries, and across the continents of the earth.

PURPOSE OF THE INVESTIGATION

The purpose of this investigation is to identify and define the values available to mankind of botanic gardens, with emphasis being given to design evolution and to aesthetic considerations. In order to accomplish this purpose, an intensive study has been made of research material attesting to the occurrence and development of botanic gardens from as early as 1500 B.C., according to currently available records. The information encountered hereby, it is hoped, will have significance leading to a better understanding of today's botanic gardens as well as a more general realization of potential and challenge in the planning of botanic gardens for the future.

DEFINITIONS

For purposes of this investigation it is essential, although sometimes difficult, to draw a clear line between a garden, a park, and an arboretum or botanic garden. A *garden* is

created for personal enjoyment and recreation, and in most instances is private. A *park* is established primarily for public recreational use and enjoyment. An *arboretum* or *botanic garden* differs from both in its conscious effort to maintain an atmosphere conducive to study, scientific research and advancement, as well as enjoyment, relaxation, and aesthetic pursuits. For this reason, certain necessary restrictions are commonly observed, which are related to the achievement of these purposes. Therefor picnicking is not allowed on the grounds of botanic gardens proper, although facilities are often located nearby; dogs, bicycles, and automobiles are excluded from the gardens. A level of sophistication in behavior is expected which will thereby further the objectives and goals, and which will be suitable for an institution of as great cultural value as any museum or art gallery. Indeed, the botanic garden is a museum of living material.

Botanic gardens (or *botanical gardens*—the terms are interchangeable) is a term now used to describe any of the great plant collections found in many parts of the world. When such gardens are concerned primarily with the collections of trees, they are called *arboretums* (or *arboreta*).

Potential and aesthetic values to be gained by the public assume paramount importance in many of the present day botanic gardens investigated. The collections are in all cases labeled, or recorded for study; they usually include among their functions opportunities for research into culture, use, and improvement of the plants.

Arboreta and botanic gardens are located over a wide range of climatic conditions. There are some gardens where only ninety days of growing weather can be expected between frosts. In some of these, extensive greenhouses are used to grow and display the collections. Rainfall ranges from less than ten inches a year to more than sixty inches, with minimum temperatures ranging from 30 degrees Fahrenheit to -40 degrees, and with maximum temperatures as high as 115 degrees. From these indications it is evident that botanic gardens are able to meet and contend with a wide range of conditions, and grow and display an even wider range of plant materials. The plants grown include ornamentals, potential economic or other research materials, and classic study plants as well as curiosities. In most cases, both native and exotic plants are grown for exhibit.

LIMITATIONS AND EMPHASIS

All the goals and purposes signficant in the evolution and development of botanic gardens must be considered (and will be considered in this study) for full understanding of the history and importance to mankind of botanic gardens. However, in this paper, major emphasis is to be given to the aesthetic and passive recreational aspects. This is not to depreciate one phase or another, or to claim greater or less importance for certain specific aspects. It is, however, deliberately to select the aesthetic and passive recreational aspects for a focus in this study of botanic gardens and arboreta.

ORGANIZATION OF THE STUDY

The chapters to follow will deal, respectively, with these facets of the botanic garden: the history, values in present day gardens, evolution of design and design considerations, proposals for future development.

The history of the development of botanic gardens is to be traced from 1500 B.C. to the present. Histories and development of specific gardens are included to offer the reader a more complete background and understanding of the problems involved in developing a botanic garden. Who the persons were in connection with the early gardens, their ideals and purposes and dreams—such information aids understanding; so does information regarding site selection and acquisition, as well as that having to do with securing botanical collections in addition to financial support. Clear and similar patterns in the reasons for development are repeatedly seen as the separate histories are told.

Values found in many of the present day botanic gardens are greatly varied; they are to be shown as including scientific research, plant introduction and varietal improve-

ments leading to economic advancements, educational uses, recreation and pleasures, and aesthetic experiences for the public. Specific examples are to be cited for each of these values. A definite affirmative answer appears obvious to the question, "Is there evidence of sufficient use and appreciation of such gardens to justify their continuing development for public use?"

The evolution of design seems to have followed a definite pattern of style and its relationship to objectives throughout the history of botanic gardens, just as have the reasons for their development. Variances of style appear to correspond directly to the changing religious, social, and philosophical views of the people at given periods in time, as well as to the climatic factors of the lands in which they live. A number of specific aspects of design may be seen in this facet of the study. Some of these are to be set forth to indicate those modifications which have evolved or can be made, to assure greater experience or accrual of value from the botanic garden.

The chapter which deals with proposals for future development points out that the increasing emphasis being placed on the need for favorable public relations demands a creative and aesthetic approach to botanic garden design. Conceivably, this factor will strongly affect future development of the botanic garden as an institution. Proposing that that botanic garden serve the interests and needs of all individuals concerned and not just the plant scientist, the professional botanist, or the student, the dominant concept is set forth that gardens should be and can be arranged with regard to relationships of form, texture, color, and composition of spatial experience. This concept directly opposes that of arrangements based solely upon botanical classification, with little or no consideration given to ecological relationships or to design, but rather for a single purpose—convenience of taxonomic study. Finally, in this chapter are to be found the statements of principles derived from works of outstanding landscape architects, from studies of successful gardens (observed historically, vicariously, or by actual visitation), and from individual observation of design principles. This chapter is offered as partial answer to the question, "How can botanic gardens be planned and grown to provide deeper aesthetic impact to the visitor as well as the educational and scientific service which is primary to their purpose?"

From the foregoing, the purpose of the writer is obvious: to consider the history and design evolution of a number of botanic gardens. Hopefully, principles identified through such a study may be applied to any botanic garden or park development where the resultant effects are desired.

Chapter II
RESUME OF THE HISTORY OF BOTANIC GARDENS

EARLY GARDENS

The history of early botanic gardens so parallels the history of early cultivated plants that the two are often considered together and are said to be almost as old as the culture of man himself. The collection and study of plants for educational and experimental purposes have been conducted in association with the oldest of the scientific research institutions; such activities were carried on as early as the earliest astronomical observatories. Botanic gardens often were instrumental in the introduction, propagation, and distribution of economic and ornamental plants; for centuries they served as the centers of botanical and biological research. The records make clear that they played a leading role in the cultural history of mankind, and that they contributed significantly to the history and development of biology, pharmacology, and medicine.

Botanic gardens as institutions in an early form actually existed in ancient Mesopotamia, ancient Egypt, and pre-Columbian America, in the sense that gardens were then maintained for more reasons than just the production of food. One of the earliest of these for which there seems to be an authentic record is the Royal Garden of Thotmes III, believed to have been designed by Nekht, head gardener of the Temple of Karnak Gar-

dens. This was at Thebes, about 1500 B.C. However, the plantings consisted of little more than groves of olive trees, laid out along formal lines, with an impressionistic touch.

Mention is found of a botanic garden established in Athens about 350 B.C., by the philosopher Aristotle. Here he taught his pupils. The first director of this garden was Theophrastus, also a disciple, who fell heir to the garden when Aristotle died. Later to become known as "the father of botany," Theophrastus was able to improve the garden with funds supplied by philanthropic citizens.

The Chinese are credited with being the first to have instituted the practice of sending envoys to distant parts of the world to collect and bring back plants for cultivation for their economic or medicinal value. According to Crider, this occurred in the reign of Chuang-tze, about 250 B.C.

Many of the early gardens were cultivated primarily for economic rather than ornamental purposes. However, as might well be expected, the Greeks developed ornamental flower gardens, and like many other conceptions of Greek origin, these were borrowed by the Romans. Some of the best known of the Roman ornamental gardens during this later period were those of Lucullus, Pliny the Younger, and (in some part for medicinal plants) the garden of Antonius Castor.

Following the decline of the Roman Empire, botanic garden development went into semi-eclipse for a thousand years. The only notable records of gardens during this time were, first, of one established in the ninth century by Benedictine monks in Italy (for the cultivation and preservation of medicinal plants), and a physic garden founded in Tokyo some three centuries later. The mediaeval monastery gardens are said to have been precursors of the later *hortus academicus,* which was not developed until the seventeeth century.

By the middle of the fifteenth century, in pre-Columbian America, the gardens of Netzahualcoyotl, king of Texcoco, were well established. As in the European gardens of this period, medicinal plants were on conspicuous element. It is interesting to note that, according to the Mexican naturalist, Dr. Manuel Maldonado Koerdell, the Mexican people were far more advanced in their understanding of the curative properties of plants than were their European contemporaries. These large gardens were carefully cultivated, and they included flowers and other ornamentals "of rare diversity and fragrance" as well as medicinal herbs.

The differences between these older gardens and those of today are extensive, however. The modern botanic garden may be considered as more immediately derived from the private gardens of the herbalists in the sixteenth and seventeenth centuries. First of this category was the Padua Garden established in 1545, said to have looked as if made for an estate designed by Le Corbusier. It was planned in a radial-concentric design, after the city plan of the period.

Between the sixteenth and the eighteenth centuries botanic garden development spread very rapidly in European countries. Konrad von Gesner has stated that "By the end of the eighteenth century there were 1600 botanic gardens in Europe alone." But most of these were small, their operations were distinctly limited, and their mortality was high. Reportedly, many of them looked much like simplified Renaissance gardens, with four groups of beds forming a simple parterre, with a pergola on one side and in the center a simple fountain, statue, or arbor.

In the middle of the sixteenth century botanical gardens were first established for purely scientific purposes. Modern botany began because of the importance of vegetable drugs in medicine and the revival of first-hand study of the plants producing them. The Rea'le Orto Botanico della R. Universita di Pisa, in Pisa, Italy (1544), came to be known as the very foundation for modern systematic botany. The Padua Garden (1545), rivalling the garden at Pisa in age, was claimed as the first botanic garden developed for didactic purposes.

During the seventeenth century, it was found desirable to establish collections of plants thought to be of use in medical treatment. Though some were of superstition value only, many were actually used. Through this time, only the collections of medicinal plants (the *horti medici*) were considered to be scientific gardens, where the professor or director was of necessity learned in medicine, anatomy, or pharmacy as well as botany, and was also trained as a physician. Most of the plants in such collections were as listed in the *Pharmacopoeia,* though sometimes interesting plants from abroad were included. In this connection it must be kept in mind that however great may have been the aesthetic and intellectual satisfaction given by such plants, botany was then auxiliary to medicine, and the primary purpose of the collections was to provide living specimens of medicinal plants for the instruction of medical students. Most plants were believed to have potential use. The old term *simple* (Latin, simplum), meaning a "medicinal herb," is significant, for it implied that a plant not of virtue by itself might nevertheless be useful as an ingredient of "cure." Among the gardens notably connected with this purpose were the Leyden Botanic Garden, Netherlands (1587), the Jardin Botanique in Paris (1635), the Edinburgh Botanic Garden (1660), and the Chelsea Physic Garden in London (1673).

By the end of the seventeenth century, the botanic garden at Leyden (Leiden) was said to contain "a collection of living plants richer in kinds and more varied in form . . . than might be found . . . anywhere else in the world." Prominent in development and teaching at the Leyden garden were such renowned names as Rembert Dodoens (Dodoneaus), Charles de l'Escluse (Clusius), and Mathias de l'Obel (Lobelius). Such monumental works as *Rariorum Plantarum Historia,* and *Exoticarum Libri decem,* connected for example with the efforts of Clusius, have proved of lasting importance to systematic botany. Introduction by this garden of many bulbous plants led to founding of the bulb industry of Holland, thereby indicating an economic value to be found in botanic gardens—historic as well as modern.

At about the same time, the wealthier merchants were establishing beautiful gardens, with seeds and bulbs collected in foreign travel by their various ships' captains. Such gardens played an important role in plant introduction, though many of them are nearly anonymous historically, as gardens or as scientific institutions.

At the *Botanischer Garten,* Berlin-Dahlem, in 1679 one of the first exhibition gardens was established, thus demonstrating another important function of modern botanic gardens: exhibition of collections to the public. A further distinction came much later, with its sponsorship and publication in 1887 of the monumental work on plant classification, *Die Naturlichen Planzenfamilien.*

Over the years, then, from the earliest gardens of record, one may observe formation of purposes which correspond to and are eventually found in the objectives of the modern botanic garden.

ORIGIN AND DEVELOPMENT OF SELECTED REPRESENTATIVE BOTANIC GARDENS

For rounded understanding and appreciation of a modern botanic garden, answers to questions like these may contribute substantially: Who were the persons instrumental in initiating this project? What were their motivations and goals? What was of importance in selecting and obtaining the necessary land? What were the circumstances relating to plant collection? What major factors have influenced the development of the garden through the years?

The answers to such questions as these are presented here, with others unique to each of the gardens considered.

The Royal Botanic Garden, Edinburgh. Because medicine and botany were very closely associated in the mid-seventeenth century, it is not surprising that the Royal Botanic

Garden at Edinburgh, Scotland, owes its inception to two eminent Edinburgh physicians of the time. Influenced by the enthusiasm of Dr. Morison, the Professor of Botany at Oxford University, these men did much to promote the study of plants and of medicine. Sir Andrew Balfour and Dr. Robert Sibbald, through joint effort, established the garden in order that apothecaries might be able to learn something of the products which they sold. At the same time, with a view to providing his colleagues with reliable drug supplies, Sibbald began a study of indigenous plants from which the drugs could be derived; this study he did not confine to locally collected species. Several other physicians in Edinburgh concurred in the design and in financial support of the project as soon as land was made available for the garden. Care was taken,

> . . . to embellish the fabrick of the garden, and import plants from all places into this garden, and procure that severall of the nobility concurred on contributing for some yeers . . . some gifts lykewise were obtained of mony from the Exchequer and the Lords of Session and Faculty of Advocates, for its use . . . considerable pacquets of seeds and plants were yeerly sent hither from abroad, and the students of medicine got direction to send thym from all places they travelled to, when they might be had, by which means the garden increased considerably every year . . .

Thus in 1670 the garden was established. In 1699 more land was obtained for the plant collections, which made possible the organization of informal beds, devoted to native and foreign plants as well as to medicinal herbs. Three years later systematic plantings were established adjacent to the College grounds, but in 1776 a permanent endowment made it possible to move the combined collections to a more suitable site.

This garden was established, then, for the purpose of collecting and cultivating medicinal plants in an endeavor to improve medical training, and to provide an accurate knowledge of plants which would serve as the sources of drugs. At the present, it has been increased in size to a total of sixty acres, and it has grown in value, scope, and purposes so that it is now said to be one of the finest gardens in the world, outstanding in its beauty.

The Royal Botanic Gardens, Kew, England ("Kew Gardens"). The Royal Botanic Gardens, at Kew, England, came into being because of the interest in horticulture of various members of the British Royalty and their amassing of plant species. Early in the eighteenth century, Kew Gardens became and for a hundred years continued to be the favorite retreat of the British Royal Family. For nearly two centuries, kings and queens, royalty of all degrees, famous courtiers, statesmen, scientists, and landscape gardeners have in their turn helped to extend and to beautify the garden.

Kew Gardens as they exist today are a combination of several properties. Only two of these, however, are said to be of chief importance: the grounds attached to Kew House and called Kew Gardens, and the royal gardens of Richmond. The rest comprise grounds of the present Kew Palace and Herbarium and the gardens that once belonged to a series of houses on the south side of Kew Green, now Crown property.

Richmond Gardens, composing the western portions of modern Kew, were the grounds of the royal residence of Edward I. The private grounds of Kew House were the possession of Lord Capel, who obtained the property at his marriage in 1696. Because he was greatly interested in the collection of plants, his collections there formed the nucleus of the modern Kew plantations.

When George II became King, in 1727, Queen Caroline undertook many costly and elaborate improvements in the gardens and grounds at Richmond. Her chief professional adviser appears to have been Charles Bridgeman, a notable landscape gardener of this time and an apostle of the so-called "natural school."

Shortly after the death of George II in 1730, the property was leased to Frederick, Prince of Wales. Soon after, the landscape gardener William Kent was employed "to

design ornamentation of the Prince's Villa at Kew." At the death of Frederick in 1751 the Princess of Wales took control of the property. Interested in horticulture, she added a botanic garden of exotic plants which became a special feature of the grounds. In its planning, a third landscape designer was employed, known as Lancelot "Capability" Brown, and William Aiton, a former pupil of the Chelsea Physic Garden, was engaged as head gardener. In 1759 a large collection of exotic trees, which had previously belonged to the third Duke of Argyll, was transplanted to Kew. From this date forth, the status of Richmond as a true botanic garden has been acknowledged.

Finally the two properties were united under one ownership when George III bought the freehold of Kew House some time subsequent to 1772. Apparently they were not actually united until 1802; up to that time they were divided by an old foot road or bridle path called Love Lane, extending between Kew and Brentford. Up to the time of their union under the auspices of George III, the histories of the Richmond and Kew properties show no connection.

Sir Joseph Banks, famous naturalist, was chiefly responsible for the establishment at Kew of two objectives which are in operation at the present day: one, making Kew "a depot for the interchange of plants with Colonies . . . which must prove of great advantage to the commerce of these kingdoms"; two, realizing that the colonial expansion of England would require men trained for botanical and culturist service abroad. He saw clearly that Great Britain would require the aid of a national botanical establishment for the scientific exploration and material development of the future colonies and his aim was to secure this at Kew under royal protection. However, the decay of the King's mentality was such as to frustrate hopelessly Banks' intentions. The two men died in the same year. Apparently, however, Sir Joseph did the best thing possible under the circumstances: he left the Colonial collections, control of which he had been permitted to retain, along with the papers relating to them and his library as well, to the safe custody of the British Museum. He had not labored altogether in vain. The decay into which the garden fell brought such protests from the English scientific world as ultimately reached the throne. As a result, a committee was appointed to present a report to Parliament. This report was intended to guide Sir William Hooker, the newly authorized director. Among its recommendaitons are these:

> A national garden ought to be the center round which all minor establishments of the same nature should be arranged . . . receiving their supplies, and aiding the Mother Country in everything that is useful in the vegetable kingdom. Medicine, commerce, horticulture, and many valuable branches of manufacture would derive much benefit from the adoption of such a system. From a garden of this kind, Government would be able to obtain authentic and official information of points connected with the founding of new colonies; it would afford the plants these required.

Until 1840, then, Kew belonged to the Royal Family; in 1841 it was taken over by the government as a public scientific establishment. Kew has exerted a profound influence on the development of botanical science. By the training of gardeners, by the discovery of many plants with economic and ornamental importance, Kew has made possible the development and work of numerous colonial gardens and botanical stations. While the latter are in actuality experiment stations, they depend upon Kew for scientific advice and for much economic plant material.

The beauty of Kew can be traced to the efforts of Sir William, so long associated with the garden. He sought to make Kew so attractive as to create in the general public an interest in plants as well as to advance pure and applied botany and to train collectors and gardeners.