Zeitschrift: Boissiera : mémoires de botanique systématique
Herausgeber: Conservatoire et Jardin Botaniques de la Ville de Genève
Band: 14 (1968)

Artikel: Botanical gardens before 1818
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DOI: https://doi.org/10.5169/seals-895612

Boissiera 14: 31-46. 1969.

Botanical gardens before 1818

(With plates I-IV)

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Prehistory.

The history of botanical gardens starts much later than the history of gardening. We know from many sources of the existence of gardens, for instance in ancient Egypt and Mesopotamia. These gardens, however, were laid out for the growing of herbs or food plants, for ornamental purposes, for pleasure or as a status symbol; they can not be called "botanical".

What is a botanical garden ? It is a garden in which a collection of plants is brought together for scientific purposes. "Scientific purposes" here means the study and cultivation of plants for their own sake, not as medicinal or kitchen herbs, nor exclusively for pleasure. Human beings being what they are, they usually combine all these activities, and many a botanical garden is a pleasure to visit. This pleasure has a direct connection with another purpose of botanical gardens: education.

In this brief sketch of the development of botanical gardens, and especially of the way their plant collections grew, these two criteria, science and education, are accepted as a guide.

It is hardly relevant here to mention the gardens of ancient China, Assyria, or Mexico, even though these may occasionally have served contemporary scientists, because they had little to do with the foundation of modern botanical gardens. There is, for instance, a picture of a garden in Egypt near the temple of Karnak (± 1430 B.C.), the so-called botanical garden, with illustrations of the plants and animals brought home from his campaigns by Thetmosis III (Thoutmes III, 1490-1436 B.C.); it is possible that the founder of ancient China, the mythical emperor Shin Nang (28th century B.C.), grew medicinal herbs for testing. A list of plants grown in a Chinese medical garden during the Han dynasty (ca. 100 B.C.) includes plants such as *Litchi, Areca, Canna* and *Cinnamomum,* but this is a subject by itself. In this account I want to restrict myself to some remarks on the development of the botanical gardens of our western civilization.

Accepting the criteria of science and education it can perhaps be said (Greene 1909, Sarton 1952) that the first real botanical garden in the world was the garden

of the father of scientific botany, Theophrastus of Eresos, a Greek living in the golden age of Greece, four centuries B.C. Theophrastus was a contemporary and a friend of Alexander the Great. He had been the latter's tutor back in Macedonia. Theophrastus' school, the "Lyceum", was a group of buildings in a grove near Athens originally dedicated to the wolf-god Lycos. It is evident from his writings (see Hort 1916) that a garden was attached to this school. This garden would have contained mainly the native Greek plants occurring on the spot and the ordinary vegetables. A small number of plants may have been planted because of their intrinsic scientific interest.

In the wake of the advanced development of biology in ancient Greece, the Romans, with their practical disposition, fell back on studies in agriculture. They maintained, here and there, medicinal gardens where the students could become acquainted with the herbs. Pliny the Elder, the famous encyclopedist of the heydays of the Roman caesars, mentions a physician and medical teacher Castor and recommends the use of Castor's garden to medical students. The direct knowledge "from nature", according to Pliny, was indispensable. It may be said (Hill 1915) that the formation of the earliest botanical gardens in Europe must be attributed to the necessity for drugs.

The medieval monastic gardens originated in the time of Charlemagne, who assigned the specific task of medical training to the monasteries. There seems to be little doubt that several of them had the character of a botanic garden in that they contained collections of plants for study. The didactic element, however, was missing, and on the whole they were not very spectacular. The monasteries at St. Gallen in Switzerland and Reichenau in Germany are best known. The prior of Reichenau, Walahfrid Strabo, had been the teacher of Charles the Bold at Aix-la-Chapelle and thus must have been influenced by Charlemagne's ideas on medical education. The physic garden or hortus at Reichenau is best known through Strabo's beautiful Latin poem (see e.g. Payne and Blunt 1966). The plan of the St. Gallen garden has been preserved, as well as a list of the plants cultivated there (see e.g. Hill 1915). This latter garden was an oblong enclosure containing eighteen beds. Next to the garden was the "herbularis", which in fact was the precursor of all physic and botanical gardens to be established in later years by the universities. The garden was used for the kitchen vegetables and the fruits; the "herbularis" was the herb garden. Botany and medicine were practised by monks in the monasteries. On the whole knowledge and science were, in those ages, almost the exclusive monopoly of the monks. For laymen it was difficult to become scientists, because they had no access to the precious manuscripts. The world of learning was a closed one before the invention of the art of printing.

The foundation of the first universities in the twelfth century was a result of the urbanisation and the growth of a free citizenship. This development was one of guilds, of communities set up to protect common interests, often directed against the all-powerful monasteries. This development, however, was not accompanied by a movement back to nature to study the plants. The medieval tradition was to obtain wisdom and knowledge from the old traditional sources, the books and the codices. It was an introvert science, centered around man and the art of disputation, not directed towards nature and the art of observation. The monastic gardens remained for a long time the only centers of cultivation of herbs. Private physic gardens seem to have existed towards the end of the fifteenth century, but they too can be called botanic gardens only in a very loose sense.

The invention of book printing obviously promoted the further spread of knowledge. The first botanical books printed, however, were the old medieval herbals and scholarly edited texts of the ancient Greek and Roman writers. The renaissance was originally a philological phenomenon, a return to the study of unadulterated classical texts. The rebirth of the natural sciences was a product of a later phase of the renaissance.

Birth of the modern botanical gardens.

The return to nature study, to looking at living plants rather than at books describing plants, is a phenomenon of the first half of the sixteenth century, occurring first in Italy and soon afterwards in Germany, France and the Low Countries. It was not until this time that the main tools of descriptive botany, botanic gardens and herbaria, were developed. At the same time there was a sudden increase in plant introduction from other regions, because of the general upsurge of travel and exploration. This whole development is also reflected by a new phase in the production of botanical books, characterised by independent reporting of newly observed facts rather than by critical republication of previous sources.

The honour for two great "firsts", first in botanic gardens and first with herbaria, goes to the Italian Luca Ghini (ca. 1490-1556), who had been a professor of botany at Bologna since 1534 but who was called to the University of Pisa in 1543 or 1544. At that time Italy was again the center of the cultural world. Commerce and industry prospered. There were trade relations with the mediterranean area and with the north, and the arts and sciences flourished as a result of this economic prosperity. After the fall of Constantinople in 1453, many Greeks (and not the worst; many were artists, intellectuals and traders) had fled the country and come to Italy. Their knowledge of Greek was an essential element in reviving the knowledge and understanding of the works of the ancient Greek which was such a characteristic feature of the renaissance. Two or three generations of these immigrants left their imprint on Italian science and arts. In the sixteenth century the Turkish threat subsided; trade relations with the Orient became closer and prosperity was a natural consequence. In such a climate of widening horizons biological science prospered, and it is in this context that we must consider the foundation of the university botanic gardens of Pisa, Padua and Florence in 1544 and 1545, all established with the help of the Medici family.

The Pisa garden is no longer in its original location. For a long time Pisa and Padua disputed the honour of having had the "first" real botanical garden, but Chiovenda (1931b) produced written evidence of the existence of the Pisa garden in 1544. It seems very likely that the layout and acquisition of the ground took place in 1543. Ghini when taking up his duties at Pisa, must have immediately started planting the garden. In the summer of 1545 he travelled all over Italy and brought home living plants from the Alps and from Yugoslavia. The oldest lists of plants in the Pisa and Padua gardens show that, understandably, the plants were nearly all European, plants known from the wild as well as plants grown in cultivation since classical times. In 1543 the new world had been known for half a century, and many expeditions had begun to open up the world; however, very few of all the wonderful plants seen by those first explorers were grown in the early botanic gardens.

It was also in the Pisa botanic garden, between 1545 and 1550, that the first herbarium was made, by one of Ghini's pupils, a priest from Lucca, Michele Merini (fl. 1545). This herbarium is preserved at Florence (201 plants) and could be identified, for instance, by means of the names of the plants which correspond to those in a list of the Padua garden of that time (Chiovenda 1927, 1931a). Michele Merini was a self-made botanist who followed Ghini's courses for a while. It is likely that Ghini originated this practice of pressing and drying specimens because other known herbaria of that period all go back to the Pisa garden (see e.g. Saint-Lager 1886). This rather simple device of pressing and drying plants and of sticking them on sheets of paper was an enormous step forward in the dissemination of botanical knowledge. It was thereby possible, quite simply, for students to make authentic records of the teachings of their master, not as before solely by often misleading word pictures, but now by means of the material itself. It is an interesting point that this extremely important practice, a basic requirement for the development of botany as a study also for the layman, took place in the first modern botanical garden. We cannot look upon this as pure chance: both phenomena are the outcome of the renewed inquisitiveness and of the search for knowledge taken directly from nature and from living plants.

Luca Ghini gave the first scientific course in plant taxonomy not limited simply to medicinal herbs. He stood at the cradle of our institutional botanical gardens and our herbaria. This early history of botany is thus seen as just one small phase in that tremendous movement toward opening of the human mind and rediscovering the essential freedom of independent research.

The Padua garden, laid out in 1545, is still in its original location and is largely preserved in its original condition (Visiani 1839, Hill 1915, Chiovenda 1931b). The circular wall by which it is enclosed was rebuilt between 1700 and 1707 but on the same site. Within the wall the garden is laid out in numerous little beds with stone edgings. This geometrical design goes all the way back to the medieval monastic gardens and remained characteristic of many continental gardens until well into the twentieth century. The systematic garden at Paris, for instance, is still laid out in this way; in Holland the older botanists all studied in their early years in what they used to call dog's cemeteries. The design of the Pisa garden in 1723 (Tilli 1723, Hill 1915) is an excellent illustration.

This first phase in the history of the modern botanical gardens, until 1560, can be called the "European period". Gregor Kraus (1894) describes the history of botanical gardens with respect to the provenance of the collections. He shows that there were waves of plant introductions from different areas at different times and proposes a historical division on the basis of these waves. I have adopted his terminology and made use of his lists in the following account; in fact one of the purposes of the present paper is to emphasize the importance of Kraus's not too well known but remarkable book for the history of botany. Kraus calls this first phase "Die Zeit der Europäer – Die Eingeborenen" because there were relatively few plants from outside Europe in cultivation. In the first general treatise on botanical gardens, Conrad Gesner (1561) states that the Paduan garden was conspicuous for having some fine plants from Crete and Syria. This was to be expected, since at that time there was intensive trade with the Levant.

Gesner's inventory of the botanical gardens of his period is extremely instructive. He mentions 1106 plants, including weeds such as *Sonchus, Chelidonium,* and *Capsella,* which shows his scientific point of view. The real garden

plants, those commonly cultivated in northwestern and central European gardens at the time, numbered around 560 in the year 1561. These plants were of different origin:

1. European indigenous plants;
2. those from southern and southeastern Europe and the adjacent Levant.

Among the ornamental plants in cultivation there were quite a few of the first group, taken from showy mutants occurring in the wild of obtained in gardens. It is remarkable how many *Ranunculaceae* are among those early ornamentals: *Caltha, Trollius, Ranunculus, Delphinium, Aconitum, Anemone, Hepatica, Pulsatilla, Helleborus.* Other conspicuous ornamentals of European origin were e.g. *Corydalis, Dictamnus, Digitalis* and of course various carnations and pinks, as well as species of primroses and cowslips. The most outstanding ornamentals, however, belonged, even at this early stage, to the second, much smaller group, which came from southern and southeastern Europe and adjacent regions: the lilies, roses, the big flowered carnations, poppies, peonies, and several others. Some plants were also grown in tubs ("pot-plants"), such as *Nerium oleander, Citrus* and *Laurus.* Gesner states that these were kept in "cubicula tepida" during winter. These glass-houses were another important technical innovation of the period. At first they were simple rooms with windows facing south, and it is likely that their first use goes back again to Luca Ghini at Pisa, in 1547. As early as 1560 vegetables were sold on the Augsburg market which had been grown under glass, or at any rate not fully in the open air (Zander 1952). Heating of the glass-houses started in all probability only in the course of the seventeenth century.

Apart from the species belonging to these two main groups, there were a few others which were usually called "Indian" or "Spanish". These were often of American (Mexican) origin, but not necessarily so. Contacts with the East Indies were developing, and the Spanish and Portuguese may well have introduced a few plants from those regions early in the century. *Capsicum* (red pepper) species or varieties were possibly of East Indian origin; *Opuntia ficus-indica* (the Indian fig) was evidently American. The tomato was also known in cultivation in western Europe by 1561.

The botanical gardens founded in this "European period" were Pisa (1543-1544), Padua (1545), Florence (1545), Bologna (1547), and Zürich (1560). The dates of some of the more important later ones are: Leiden (1577; see pl. I), Leipzig (1579), Montpellier (1598), Paris (1597, although as a true collection and as Jardin du Roi only in 1626), Oxford (1621), Berlin (1679), Edinburgh (1680), and Amsterdam (1682).

The oriental period: bulbs galore (1560-1620).

Half a century later the botanical gardens of Europe looked entirely different. The change had not been brought about by introductions from distant newly-discovered continents, but by a greatly increased influx of material from south-eastern Europe and adjacent Asia. This was not a wave of countless new forms, but rather the massive entrée of a few species and genera which made the difference. The spectacular introduction of simple but beautiful, often wonderfully

fragrant flowers with intense colours, such as hyacinths, tulips, *Narcissus, Fritillaria imperialis,* lilies and anemonies has never been equalled. Few flowers have had such an effect on human activity and emotions as the bulbs that made their entry into our gardens between 1560 and 1620; in Kraus's own words: "Eine solche Fülle von neuen Blumen einfachen und edlen Schnittes, von glänzender und warmer Färbung, von berauschendem Duft, wie die neu erscheinenden Hyacinthen, Tulpen, Narcissen, Kaiserkronen, Lilien, Anemonen und Ranunkeln, ist nie wieder zugleich in den Gärten erschienen. Keine Blumen haben von Osten nach Westen ziehend einen solchen Triumphzug gehalten, solche Anregung und solche Aufregung der menschlichen Thätigkeiten und Leidenschaften hervorgerufen, wie sie: die Anwendung des Kupferstichs in der Botanik bei uns (Hort. Eystett.), die Kleiderstickerei bei den Franzosen, Zwiebelzucht und Blumenmalerei aber auch die Tulipomanie bei den Holländern."

The sixteenth century thus ended with a marvellous display of new plant introductions which must be seen against the receptive spirit of the time, both in the botanical and the horticultural respect. In the middle of the century the Ottoman Empire had reached the peak of its economic and military growth. The introduction of the new flowers, of which the tulip may serve as an example (Stafleu 1963), was the result of the very close political and economic relations between the Ottoman and the Austrian Empires. Turkey and Austria were the world powers of the time (with Spain, of course, which looked overseas).

The islamic and militarily aggressive Turks stimulated the self-defense of the Austrian Empire. A delicate balance of power developed as a result of frequent wars in which a power-line (a harem curtain) moved to and fro over the Balkan peninsula and the Danube countries. There were times of peaceful co-existence in which close contacts between the two nations developed. These contacts between Austria and Turkey led to the introduction of a great many flowers into western Europe.

The Austrian ambassador to Suleiman the Magnificent, Ogier de Busbecq (1522-1592), observed an abundance of flowers when travelling from Adrianople to Constantinople in the spring of 1554, when he still expected to see the dead landscape of winter. He saw narcissus and hyacinths and flowers which he said were called tulipam by the Turks, and he commented on the great variety and beauty of the colours of these flowers. He sent bulbs to Italy and to Austria and in this way, as well as through the normal trade routes, these plants made their spectacular entry into western gardens. Gesner in 1561 and Mattioli in 1565 described and depicted the tulip (pl. II), and from then on the genus rapidly gained popularity in Europe.

The Flemish-Austrian botanist Carolus Clusius, one of the early inquisitive natural scientists and botanical travellers, took an interest in these plants. This first scientific horticulturist and plant taxonomist lived from 1526 to 1609, a life which bridged the full period of horticultural explosion that resulted from the renaissance and the increased wealth and interest of the well-to-do civilian and aristocratic classes, as well as from the rapidly expanding trade connections with the Levant. During his years in the southern Netherlands, in Vienna, and later at Frankfurt and Leiden, Clusius was always engaged in obtaining and describing new plants. Through his many contacts he was able to take a very active part in this oriental phase of plant introduction. Through his erudite compilations (e.g. 1576, 1583), illustrated with excellent woodcuts, through his own travels in Hungary, Italy and Spain, and through his many connections inside the powerful Austrian

Empire, Clusius became the dominating figure in botany between 1550 and 1600. He was director of two important botanical gardens, Vienna and Leiden, and in print as well as through exchange of material he greatly influenced the development of botanical gardens all over Europe. His "Rariorum aliquot stirpium per Pannoniam..." (1583) is a particularly important document illustrating the oriental phase of plant introduction. It starts off with two relatively recent imports from Turkey: *Prunus laurocerasus* and *Aesculus hippocastanum.* Many other oriental ornamentals are treated in great detail, several of them for the first time. The book contains, for instance, an extensive monograph of the various species and cultivars of *Tulipa* then in cultivation.

The tulips and the other oriental bulb plants were not yet grown in masses but individually, for their variety. Propagation was by seed as well as by bulbs, and it was of course mainly through the propagation by seed that the exuberant variety arose.

Even though the oriental bulbs, and especially the tulips, dominated the picture of this second phase, there were quite a few other introductions. Kraus (1894) mentions among others the following:

1. Many other orientals such as *Muscari, Scilla, Fritillaria, Narcissus tazzetta,* and *Gladiolus* were brought into cultivation (Clusius 1583, Stafleu 1967b).
2. The number of cultivars of carnations and pinks increased greatly.
3. Plants such as the common lilac *(Syringa vulgaris)* and the syringa or mock orange *(Philadelphus coronarius),* flowering shrubs from the east, also came in from Turkey. The lilac was known in Italy as early as 1554: Mattioli had received this plant from de Busbeck from Constantinople with the annotation that the Turks called it "lilac". Soon after 1560 it found its way into central and northeastern European gardens; a specimen is preserved in Cesalpino's herbarium of 1563. The mock orange came a little later. Other pretty flowering shrubs introduced about that time were *Prunus laurocerasus* (also from Turkey) and the Siberian *Spiraea salicifolia.*
4. The horse chestnut *(Aesculus hippocastanum)* has a similar history. It was again Mattioli, the Italian botanist and, in a way, successor to Luca Ghini, who received the plant from Turkey through the help of another Dutch-Austrian ambassador, Willem Quackelbeen, in July 1557. Clusius planted it in Vienna around 1576. The tree came into flower for the first time (at any rate as far as recorded) in Frankfurt in the year 1603. It remained a great rarity for a long time.
5. The first American plants came via Spain. Apart from *Zea mays* (corn; cultivated by Fuchs in 1542), *Canna* and *Capsicum*, mentioned before, there were plants like *Helianthus,* the sun-flower, *Nicotiana,* the tobacco (two species), *Tropaeolum minus, Mirabilis jalapa, Agave americana, Tagetes* and the potato (1565 first plants in Madrid). These were mostly plants from the higher regions of Mexico and South America having seeds or tubers that could easily be transported.
6. A first sign that another period approached: *Thuja occidentalis* (American arborvitae) was brought to Paris from Canada very early in the seventeenth century. This tree was easily propagated and (contrary to the horse chestnut) spread quickly and easily throughout Europe.

So far continental European gardens had taken the lead. England, the undisputed leader in horticulture from napoleonic times on, lingered behind in the sixteenth century. The tulip reached England in 1577; *Narcissus, Hyacinthus, Opuntia, Anemone, Helianthus* in 1596, the lilac in 1597. On the continent it is interesting to note that by the end of the "Oriental period", around 1620, the center of activity had shifted from Italy to Austria, Germany and especially to the Netherlands. These three countries with their flourishing trade and economy were mainly responsible for the unrivalled horticultural explosion of this period.

The period of the Canadian-Virginian perennials (1620-1687).

"Die paar amerikanischen Pflanzen, welche bisher nach Europa gekommen waren, stammten zumeist aus den hochgelegenen Ländern Südamerikas, auch Mexicos und waren von den Spaniern heimgebracht worden. Neben den Bezeichnungen "indisch" und "amerikanisch" werden die Beinamen "spanisch" und "peruanisch" synonymisch bei ihnen gebraucht ... Es waren Sommerpflanzen mit leicht angehenden Samen (Helianthus annuus, Nasturtium indicum) oder unverwüstliche Knollen (Kartoffel, Mirabilis, Agave, Opuntia). Dass keine eigentlichen Tropengewächse heimgebracht wurden, versteht sich ganz von selber; sie vertrugen weder die unendliche Schifffahrt, noch, ohne warme Einrichtungen, die europäischen Winter; erst nachdem Länder mit gemässigten Klimaten aufgeschlossen waren, konnte die erste Masseneinwanderung erfolgen und das Antlitz der Gärten im freien Lande verändert werden. Das war, als die Engländer Virginien und die Franzosen Canada in Besitz nahmen. Aus beiden Landstrichen wurde Beute in Menge gemacht, für den europäischen Continent jedoch sind die französischen canadischen Besitzungen in erster Linie bedeutungsvoll geworden." (Kraus 1894).

Paris is now a new name in our story. The capital of France, which had so far been outside the mainstream of the development of botanical gardens, assumed a rôle. The first introductions reached France in the first twenty years of the seventeenth century; the arborvitae has already been mentioned. With the diminishing of Spanish rule as a result of the increased sea power of the English and the Dutch, the French saw their chance. The Dutch were more directed towards the tropics, in the east as well as in the west, and to the Cape, the English to "Virginia" (in the historical, wide sense); the extensive forests and lakes of Canada with their fur trade became the domain of the French. Among the plants which they brought home were a few trees and shrubs, but, at first, mainly perennials. Examples are *Rhus* (the sumach as well as the poison ivy; see pl. III), *Tradescantia, Robinia,* and such plants as *Corydalis* (Dutchman's breeches), *Trillium, Solidago* (goldenrod), *Rudbeckia* (black-eyed Susan) and many others. Many of them are described and illustrated in Cornuti's "Canadensium plantarum ... historia" (1635; see also Stannard 1966) and were grown in the Paris "Jardin du Roi". This garden had been started around 1597 but it came really to life only in 1626. In 1636 Guy de la Brosse published a catalogue enumerating 2133 species of plants. By 1665 (Joncquet) this number had grown to nearly 4000 species, of which about 2% were Canadian. The story repeats itself: the plants characteristic of a period are a minority. The great majority of species always stemmed from Europe.

The royal garden at Paris was in no way a palace garden. On the contrary, it was an independent educational and scientific institution with a royal endowment, originally founded as an establishment to promote the teaching of pharmaceutical botany. As an institution it was, and always remained, independent of the Sorbonne, the University of Paris, as well as of the palace gardens of royalty. Three physicians were appointed to "demonstrate" "l'intérieur des plantes". The royal act of foundation also provided for a special cabinet in which dried specimens of plants, as well as other rare items of natural history were to be preserved. The garden flourished from the beginning, but in later years, all through the eighteenth century, it became a much more important institution than a garden alone would have been, because of its independent development as an institution where the life and earth sciences were practised. The staff increased and departments of botany, zoology and mineralogy were created. The teaching of botanical and zoological illustration occupied an important place. As a center of biological learning it soon assumed an undisputed first place in Europe, even when compared with university establishments. Many of France's greatest botanists made their career at the "Jardin du Roi", also called the "Jardin des plantes". Even now its collections, and certainly its herbarium and palaeobotanical and palaeontological departments, are among the world's richest. The development of the Paris garden, with its fascinating history and picturesque personalities, has been treated several times. Important from our present point of view is that the Paris garden is the oldest and most important non-university botanical garden still in existence. This botanical garden is still in its old location; the oldest tree in it is a *Robinia* planted in 1636 by Robin himself.

The French were very liberal with their plants, and the Canadian trees and perennials quickly found their way to other countries. However, I shall not elaborate upon the introduction of these plants into the gardens of other countries, except for the interesting fact that the English gardens seem to have received several of their first North-American plants from France. Judging from Aiton (1789), a plant like *Tradescantia* was grown in England for the first time some ten to twenty years after it was first reported for e.g. Paris and Basel. The first lists of the Oxford botanical garden contain very few new plants, by comparison with the continental gardens; the collections were distinctly poorer. A few decades later private botanic gardens in England, such as that of Bishop Compton at Fulham and the garden of the Tradescants at Lambeth, had early Virginian introductions: *Magnolia virginiana, Acer rubrum, Tradescantia virginiana, Liriodendron, Aralia spinosa, Juglans nigra, Rhus copallina,* and so on (Taylor 1967). This is the second phase of this period, the beginning of the direct English introductions from Virginia. These introductions found their way slowly into continental gardens, first mainly towards Holland. A third wave of North American plants, after the French (from Canada) and the English (from Virginia) came to Holland. The Dutch also had settlements in North America, for instance on the island of Manhattan, from which they introduced plants into the Leiden and Amsterdam gardens. *Aster novi-belgii* and *Aster novae-angliae* were among them.

The total number of taxa represented in botanical gardens increased steadily. The catalogues of the Leiden garden around 1600 (Paaw 1603) listed about 1000 species; towards the end of the period the Paris garden claimed nearly four thousand species (Joncquet 1665). The "Jardin du Roi" must have been by far the richest garden of the period. It should be stressed again that this increase in number did

not stem from the American introductions alone: numerically the increase in number of continental European plants was much more important. The Paris garden had, for instance, rich collections of Spanish plants.

The "Capzeit": succulents, ericas and geraniums (1687-1772).

Gesner (1561), as mentioned previously, stated that plants grown in tubs or small pots were taken to frost-free rooms during the winter. These glass-houses were an Italian invention (1547), but they were soon being constructed elsewhere, e.g. at Leiden in 1599 (the Leiden gardeners had studied and travelled in Italy). Soon after the construction of the Leiden houses winter heating must have been introduced. In 1656 we find heated houses for plants in Altorf near Nürnberg (Baier 1727). The first unheated houses were called "solaria" (sun-houses); they would now be called conservatories. In the middle of the century Leiden too had more sophisticated glass-houses which could be heated from below. The names for them varied; they were mostly in Latin: solaria, hybernacula, hypocausta; "Glashäuser" in Germany; "glass-houses" in England; in Dutch simply "kassen". The development of the glass-houses was accelerated by the introduction of an entirely new group of plants: The second half of the seventeenth century witnessed a true invasion of plants from the Cape of Good Hope.

The Cape of Good Hope was discovered by Bartolomeo Diaz in 1488 and rounded for the first time in 1499 by Vasco da Gama. The Portuguese maintained a trade route to the Indies via the Cape all though the sixteenth and seventeenth centuries. They made no permanent settlement, but the Dutch soon grasped the strategic and economic importance of the place, especially for replenishing supplies of fresh water, food and other provisions. A permanent port was set up by Jan van Riebeeck for the Dutch East India Company in 1652. The Dutch trade with the East Indies increased greatly during the seventeenth century, and Holland entered its golden age. The wealthy merchants were interested in growing exotic plants in their gardens, or, like the patrons of the Commelins in Amsterdam, in increasing the riches of the university botanical garden of which they were governors. The Dutch Republic, newly independent, a refuge for intellectuals from all places where freedom of religion or political thought was impossible, reaped a harvest of energetic commercial and scientific immigrants.

The great economic and scientific expansion brought about an enormous increase in plant introduction and enriched the Leiden (and Amsterdam) garden rapidly, especially during Hermann's and Boerhaave's directorship of the Leiden garden. Schuyl (1668) lists 1827 taxa, Paul Hermann (1687) 3846 and Boerhaave (1720) 5846. The latter describes this development in great detail in the introduction to his "Index alter" (1720), stating that "practically no captain, whether of a merchant ship of a man-of-war, left our harbours without special instructions to collect everywhere seeds, roots, cuttings, and shrubs and bring them back to Holland". The great driving power behind these activities was in first instance Paul Hermann, a German immigrant, native of Halle, who travelled in South Africa, India and Ceylon between 1672 and 1680. In 1680 he became professor of botany at Leiden, and with this appointment the enormous increase in the plant population of the Leiden garden started. At about the same time (1682) Jan Commelin at

Amsterdam was appointed by the governing board set up by the municipality to create a new botanic garden (for details see e.g. Stearn 1961). He and his nephew Caspar did for Amsterdam what Hermann did for Leiden. All three were in close contact with the great shipping and trade magnates of the Netherlands, and these wealthy merchants started to become interested in plants and gardens themselves. All their ships to the east went by the Cape of Good Hope, and the opportunities for plant introduction from that exceedingly rich promontory of Africa had never been so good. The sea voyage was relatively short, much shorter than the voyage from India, and local people at the Cape could supply the returning vessels with the plants.

One of the most renowned private botanical gardens of the period was that of George Clifford (1681-1760), a wealthy banker, who in 1709 had acquired a second house south of Haarlem, in the pleasant dune region. At this estate, called De Hartecamp, he started an exquisite collection of living plants and animals. He built conservatories, and probably also glass-houses, and assembled a considerable number of permanent collections, one of which was the herbarium which is now at the British Museum. It is not strange that the young Linnaeus went to Holland to complete his botanical training. In Amsterdam and in Leiden he found exquisite collections, with the latest plant introductions, often of families quite unknown to him. Clifford employed him from 1735 until 1737 to describe the collections of De Hartecamp, and during that time he became acquainted with some of the prominent botanists of the era: Johannes Burman, Jan Frederik Gronovius and Herman Boerhaave. Holland also had excellent botanical libraries and expert printers. Linnaeus, who had brought many manuscripts with him, was able to finish and publish here many of his most important books, such as the "Systema naturae" (1735), the "Bibliotheca" and the "Fundamenta botanica" (1736) and the "Genera plantarum" (1737). Most important of all, perhaps, was his impressive folio "Hortus cliffortianus" (1737), offering ample proof of the rich variety of plants in Clifford's garden, including many Cape introductions.

Gregor Kraus cites as characteristic for the "Capzeit":

1. Succulent plants in the broadest and oldest sense of the word, such as:
   - Succulent euphorbias, of which Commelin's "Hortus amstelodamensis" (1697, 1701), for example, gives such marvellous pictures.
   - *Mesembryanthemum* (ice-plant), called *Ficoides* because of the fig-shaped young fruits, a name given by Hermann.
   - African *Aloë* and related genera such as *Haworthia, Apicra,* and *Gasteria:* Commelin illustrates not less than 30 species.
   - Stapeliads: the famous "Fritillaria crassa" of Stapel (1644), and a few other species. They remain rare.
   - *Crassula, Rochea* and *Cotyledon.*
   - The first succulent *Oxalis* species.
   - Big bulbs such as *Haemantus coccineus* and *Ornithogalum capense.*
2. Geraniums or pelargoniums (Commelin, 1697, gives the first pictures of *Pelargonium zonale* – see pl. IV – and *P. peltatum*).
3. Numerous other groups, such as woody species of *Polygala* and *Hermannia.*
4. Herbaceous species of *Lobelia, Gnaphalium,* etc.

5. *Proteaceae,* such as *Protea argentea.* The Commelin plates are all based on drawings made at the Cape. Young plants succeeded in Amsterdam but flowers were rarely, if ever, obtained.
6. *Erica* species. These came late, towards the end of the eighteenth century.

The Cape flora quickly found its way to other European gardens, especially plants such as *Pelargonium, Aloë* and *Mesembryanthemum,* which were not difficult to grow. In this period Holland was the great center of plant introduction and distribution, a rôle which it has never since played to that extent, with the exception of the bulb trade. The early Cape plants reached the English gardens also somewhat later and almost exclusively via Holland; in the course of the eighteenth century, however, direct introduction into England increased rapidly in volume and importance.

With the hectic activity of travelling in the golden seventeenth and eighteenth centuries, many plants were also introduced into botanical gardens from other parts of the world. There is, however, no single predominant group that can be compared with that of the Cape plants, although introduction continued, for instance, from the Americas. The flora of the glass-houses in the eighteenth century outside England and Holland consisted mainly of the Cape plants and of the old mediterranean collections. The German, French and Italian gardens could no longer match those of Holland and England. The number of plants cultivated in the gardens increased steadily. Leiden, according to Boerhaave's index of 1720, was the mother garden, with nearly 6000 species, or at any rate kinds. Linnaeus had 987 species in Uppsala in 1748; the Scandinavian gardens remained relatively poor, even for quite a while after Linnaeus's return from Holland. His successor Thunberg, however, a botanical traveller who started a program of introduction of his own, had 2906 by 1800 (Thunberg 1803).

North American trees and shrubs (second half of eighteenth century).

Among the Canadian-Virginian introductions of the seventeenth century were relatively few woody plants. The English colonial expansion in the New World, however, resulted in a new wave of often woody immigrants to our botanic gardens in the second half of the eighteenth century, after the heydays of the Cape plants. With the rich assortment of woody plants from America came the English revolution in gardening of the eighteenth century, the development of the landscape style, much freer than the rigid formality of most of the continental gardens. From this period on England definitely took the lead in horticulture and kept it until the present. The economic and colonial expansion of England came after that of Holland. At the time of George Clifford, when Linnaeus was in Holland, the economic welfare of that country reached a peak, but this meant that the end of the drive had been reached. Cultural development accompanies economic expansion but lasts longer. The English landed classes increased their wealth by means of the development of early industry and of the international trade. The

rural style of living of the upper classes brought about the parks and estates, where a new gardening style could be developed. The new trees from America needed space, and this was exactly what was lacking in the continental botanic gardens. English private gardens took the initiative. Many of them could really be called botanical gardens because of their collections.

Famous gardens in England were those of Peter Collinson at Peckam and later at Mill Hill and of James Sherard at Eltham, and the apothecaries' garden led by Philip Miller in Chelsea. Important figures in this respect were people like Mark Catesby, traveller in Virginia between 1712 and 1729, and a resident of the Philadelphia area, John Bartram. The latter established the first botanical garden in the American continent on his estate on the Schuylkill River near Philadelphia, in 1731. In this garden he could study and propagate his plants before he shipped them to England, mainly to his most faithful correspondent Peter Collinson (Darlington 1849), and via Collinson to Philip Miller. Well-known plants discovered and introduced by Bartram and Collinson are, for instance, *Franklinia alatamaha,* now known only in cultivation; *Kalmia verticillata, Rhododendron maximum, Ilex verticillata, Epigaea repens, Spiraea tomentosa* and several species of *Celastrus, Chamaecyparis, Quercus* and *Tsuga* (see Ewan 1967, Stafleu 1968). Through Collinson many of the American introductions reached, among others, Philip Miller's garden at Chelsea and the new gardens at Kew of Princess Augusta, which were ably managed by William Aiton as gardener and Lord Bute as superintendent. These gardens soon ranged among the richest of the world, not in the least because they were laid out at the height of plant introduction from the New World.

Bartram was not the only botanist responsible for this wave of new plants; several other names of American collectors and botanists should be mentioned: John Clayton, Cadwallader Colden, Benjamin Franklin, Alexander Garden, for instance. It would lead me too far afield, however, to discuss their contributions to horticulture and botany in any detail.

The history of eighteenth century botanical gardens is a subject by itself, ably treated by W. T. Stearn (1961), G. Taylor (1967) and others. Here, it is possible only to sketch the main lines of development. With the introduction on a wide scale of the North American trees and shrubs, as a result of pre-revolutionary contacts between England and what were then still its American colonies, and with the rising power, socially, economically and culturally, of eighteenth century England, the long-time continental lead in botanical gardens came to an end.

The introduction of these North American woody plants (hemlocks, red cedar, *Taxodium,* maples, oaks, walnuts, *Hamamelis virginica,* various species of *Prunus, Amelanchier,* etc.) into continental gardens was a slow process. The gardens were usually too small to accomodate new trees and shrubs. The continental European botanical gardens had kept their closed character and still showed that they had originally been developed from the walled or fenced-in monastery and herb gardens with their small rectangular beds, mostly located in the towns or immediately adjacent to them.

The English style of gardening, however (exemplified for instance by the Kew Gardens), was an open landscape type, spacious, designed for aesthetic and intellectual pleasure. This style was later followed on the Continent, but on the whole not in such a spectacular way as in Britain.

Introductions from New Holland and Oceania.

The next distinct period in the growth of the populations of botanical gardens is that characterized by the wave of "New Holland" plants, that is mainly from Australia, Tasmania and New Zealand. Here again the British gardens were the first to reap the profits from a new development in exploration, with the French second in line.

The first voyage of captain Cook (1768-1771) marks the beginning of the era. Cook was accompanied by the illustrious Joseph Banks, the undisputed leader in British natural science between 1770 and 1820, from 1778 on president of the Royal Society. The subject of the exploration of Oceania by the English and the French is intriguing but cannot be treated here in any detail (see e.g. Bernard Smith 1960, Stafleu 1967a). It is interesting to note that the exploration of the South Pacific area occurred long before the continents were opened. So far in the history of botanical gardens and of plant introduction we have always come across the phenomenon of introduction via the great sea lanes. The Mediterranean area was a cradle of civilisation perhaps because there was the central sea with its relatively safe trade routes. Travelling on the high seas and the oceans was simpler and safer than travelling deep into the continents, and it remained that way until well into the nineteenth century. The interior not only of Siberia and China, but even also of the Balkan peninsula, Turkey, Arabia, and North Africa, remained relatively unknown during the eighteenth century, whereas a knowledge of many of the islands of the Pacific soon became routine. Most of the plants from the Cape came from the small marginal zone along the sea, far fewer (and only later) from the interior; the plants from Virginia and Canada came at first only from the provinces near the Atlantic ocean (the conquest and exploration of the American West did not take place until the nineteenth century).

We must look upon expeditions like that of Cook, La Peyrouse and many others in this light. Notwithstanding the dangers of the high seas, travelling by ship was considerably safer than travelling on a continent. Ships like the "Endeavour" were travelling fortresses and laboratories at the same time, especially if they could operate in small numbers and not alone. The plants could also be cared for much more easily on a ship than on any sort of continental caravan. This is the reason why Tasmanian gumtrees and acacias appeared in our gardens considerably earlier than, for instance, the primroses and rhododendrons from China. It is not necessary to sum up the New Holland riches: in addition to the species of *Eucalyptus* and *Acacia* there were the *Proteaceae, Casuarinaceae* and many other usually unfamiliar representatives of southern hemisphere families.

Distribution of these plants among the continental gardens was through England. Only the French imported plants directly and to a limited extent (Labillardière). Introduction was slow here. First there was the Napoleonic period, during which the introduction into England reached a peak, but then the continent was isolated. Afterwards there were no abvious barriers, but several curators of botanic gardens on the continent whispered that they thought the English put their New Holland seeds in a hot baker's oven before sending them out. The seeds rarely germinated, and as a result the gap between English and continental gardens remained wide.

The nineteenth century.

After the Napoleonic era the world was opened up quickly. The industrial revolution had its way. Better ships were built, steamships soon appeared, the continents were opened by railroads. Technological innovations made it possible to construct greenhouses for tropical plants. Most characteristic of the nineteenth century is, therefore, the coming of the tropical plants and those from the American West should be mentioned. Japan opened its harbours. An entirely new element was the establishment, in 1817, of the first tropical botanical garden in Bogor, Indonesia. The botanical gardens rapidly lost their character of small herb gardens and became bigger and bigger. Large arboreta were established, and every self-respecting university started a botanical garden or made plans for it.

When, in the course of 1818, Augustin-Pyrame de Candolle started planting his new botanical garden on the Cours des Bastions (the preparatory ground work had begun during the previous year; see Candolle 1862) he stood, therefore, in many respects at the beginning of a new era. In the years in which he developed the Geneva botanical garden communications rapidly improved, after having been disrupted for too long a time by the "Napoleonic pause". Plant introduction was simpler than ever before, either directly from the native countries or indirectly by exchange or trade with other gardens. De Candolle's many international contacts ensured a rapid development of the collections. This part of the story, however, does not belong in this sketch, which is only intended to place the history of botanical gardens in the perspective of the growth of western culture.

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