

# Tempering the Elements: Botanic Gardens and the Search for Paradise

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**ABSTRACT:** This paper investigates the enhancement of natural phenomena through the use of architecture and architectural elements. How can the external environment be modified to our advantage through a series of architectural interventions? As a case study I will explore the development of the typology of Botanic Gardens and associated buildings, as examples of areas where artificial environments have been created, taking into account their purpose as locations of scientific experiment and education, and their incidental use as pleasure gardens. I will examine and assess the success and failure of particular existing sites conditions through topological and historical analysis. The paper will examine environmental factors such as light, wind, temperature, and assess how they can be enhanced to create environments that contrast with the standard external conditions. The current viability of Botanic Gardens will be assessed.

**Keywords:** low energy, climate

## INTRODUCTION

In Jane Smiley's novel *Duplicate Keys*, Henry a botanist at the New York Botanic Garden shows Alice the gardens for the first time:

"They stepped down from the formal promenade into, and among, the more spacious spreading of grass and lilac bushes covered with white lavender, and magenta blossoms. Alice gasped, both at the sight and the sweet fragrance. "The Botanic Garden," he went on, is actually a fairly thriving ecosystem. "

"It's like heaven"

"Yes," Henry said, "it is. The funny thing to me, is that there is very little vandalism. Sometimes people pick flowers, but no one writes on the trees or defaces them or hurts them..." [1]

Alice's response to the place and this exchange between the two friends encapsulate the issues raised by botanic gardens that I shall discuss in this paper.

As an architect concerned with the relationship between buildings and the environment I have become interested in the history and significance of botanic gardens and am curious as to why so many have been neglected over the last half century. The one at the university in my hometown has all but vanished, yet it holds a magic from what was clearly more than just a clinical outdoor laboratory. While discussion is frequently directed toward the dwindling resources of the planet it seems appropriate to look at institutions such as the botanic garden and re-evaluate their role in aiding us to further our knowledge of plants and their potential to create a more sustainable future for a fragile earth.

The unique nature of botanic gardens has developed in two directions. They were originally established and remain as out-door laboratories for scientific research, to describe and study the diversity

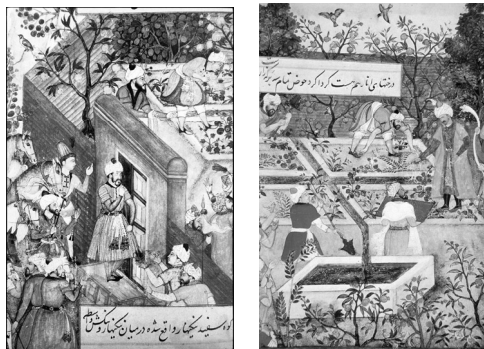
of plants. They play a key role in researching botanical resources that can assist in meeting human needs in many ways such as medicine, food production, fabric, building materials, and conservation. They are also gardens, places that, almost by default are there for enjoyment and pleasure as much as objective scientific observation. An 'artificial' environment is created through the placement of architectural components that modify the climate. The environment they create contributes to the successful growth and propagation of rare and exotic plants that delight and intrigue us, appealing both to our aesthetic sense and to a desire to comprehend the orders of the natural world. I shall demonstrate how these aims are achieved through architectural innovation, looking in particular at walled gardens and glass houses.

## ORIGIN

European botanic gardens, as we know them today, first appeared in the Renaissance. The Hortus Botanicus emerged in several European cities, and was usually attached to universities. They developed from physic gardens, for the cultivation of exotic and medicinal plants, the earliest being created in Pisa in 1543 [2]. Botanic gardens were born out of a desire for a rational connection between nature and ourselves. They were established for "glorifying God's creation and studying what wonders he had wrought in the plant world" [3]. In 1621 the Oxford University Botanic Garden was created through an endowment from Sir Henry Danvers as a physic garden "whereby learning might be improved" [4].

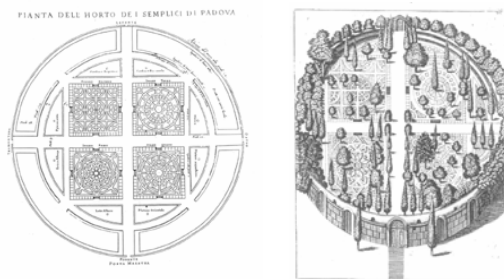
They were designed on the principle of the paradise garden. Universities such as Padua, established in 1545, were influenced by the scientific advances of the Middle East, and it was therefore

thought appropriate to use the paradise garden, which alludes to the Garden of Eden and follows descriptions from the Quran, as a model. This made it compatible with Renaissance ideas that focus on the importance of pure geometry perceived in nature. The plan of Padua Botanic Garden for instance is a perfect circle enclosing a square. The paradise garden, also based exact geometry, was an area separated from its surroundings, away from the untamed world around it in a bounded area within which an artificial environment could be created. Through the use of water, a valuable resource in a dry and arid land, and the modification of climatic conditions, a representation of paradise could be created and enjoyed. It was possible to create small pockets of land where 'Eden' could be re-created in contrast to its harsh surroundings. A fountain would be positioned centrally from which four water channels flowed, representing the four rivers that divided the four quarters of the world.



**Figure 1** Babur supervising the Garden of Fidelity, by Bishndas and Nanha 1509

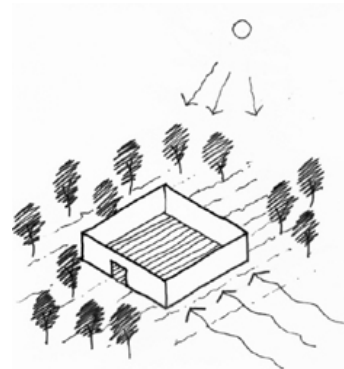
Early botanic gardens also placed a fountain centrally to represent God, but two intersecting paths laid out along the cardinal points replaced the four rivers of the Islamic garden.



**Figure 2** Padua Garden Layout, Porro, 1591 and image of garden, 1654

## CHARACTERISTICS OF EARLY BOTANIC GARDENS

These gardens follow a pattern, separating themselves from their surroundings, simply achieved by building an enclosing wall. The wall both physically separates the garden within from the outside world, and visually cuts it off by removing spatial continuity with the horizon. Views out are either dislocated, as in the case of the view of a distant spire, or controlled, such as the view through a gate or hole in the wall. Demarcation from the surrounding environment creates a safe haven, allowing control from within, and keeps out unwanted intruders.



**Figure 3** Diagram of an enclosed space, 'outdoor room'

This 'outdoor room' is now shielded against the prevailing wind, and the mass of the wall, particularly on the south-facing side, can absorb heat during the day and radiate it out at night thus creating a more constant temperature than that of the world beyond. Here is a space suitable for the culture of exotic plants and for protecting tender ones that have been brought from hotter climates.

For these pragmatic reasons, gardens such as those at Oxford and Padua have distinct proportions and create an atmosphere that allows us to enjoy a sense of enclosure. Once we are within the walls we experience the senses of containment and dwelling that the wall provides. With no spatial continuity with the outside world, places elsewhere in the city are only glimpsed at a distance. The surrounding walls are ever apparent. Shelter from the elements makes one feel safe. Senses are highly tuned by the intensity of the place. The wall acts as a sound barrier and the outside world is muffled, increasing the intensity of noises within the walls, so that one is acutely aware of the sound of the trickle of water from the fountain, of the birds in the trees, or the crunch of one's footsteps on the paving. The sheltering of the garden from the wind helps intensify the fragrance given off by the plants. Here we have nature enriched and concentrated for our benefit. Here plants are laid out for a specific scientific purpose, but laying them out as a garden also produces a rich environment which delights us and provides a place to dream, that in today's world can counterbalance the chaos and stress of urban existence.



**Figure 4** Garden within the wall

When we look at the geometric layout we see the conflict between scientific endeavour and garden design. The geometry of the gardens was originally laid out in symmetrical patterns, following fashionable patterns, but there was one crucial divergence. The need to have a layout that responded to the classification of plants led to a radically different aesthetic to pleasure gardens. Organising plants by genus took priority over composition based on shape, form or colour. They did not follow the pattern of other contemporary Renaissance gardens where geometry was also key to the design, but where the form and overall shape took precedence. This contributed to the uniqueness of the typology of botanic gardens, and the conflict between the demands of geometry and taxonomy did not produce a negative result.

The aesthetic of botanic gardens was also evident in other ways. Their status was reflected in the design of the enclosure. To reinforce the importance and high status of botanic gardens the walls were carefully constructed from high quality well cut stone, frequently endowed with elaborate thresholds, as seen at Oxford and Padua. This simple architectural statement proved very successful. Even the notebooks for cataloguing, were designed by artists. The L'Horto de I Semplici di Padua was designed by the artist In Girolamo Poro.

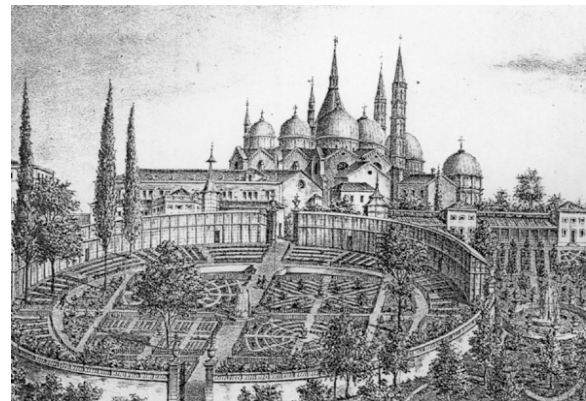


**Figure 5** Entrance to Padua Botanic Gardens, and view through side entrance

## DEVELOPMENT

There has been a continuing experimentation with the creation of particular environmental conditions for growing a range of exotic plants. As early as the 16<sup>th</sup>

century explorers were bringing back quantities of rare plants. These required special care. John Tradescant, who travelled widely in the mid 17<sup>th</sup> century is known to have constructed double skinned walls with fireplaces set in at intervals so that smoke could spread through the cavity and warm the entire wall at night, in order to prevent any sharp drop in temperature affecting the more delicate plants [5]. In Leiden forcing houses were re-invented, following discoveries of ancient Roman horticultural practice. The properties of glass were increasingly exploited. Glass could be used to enclose large areas and enhance what now became a completely internal environment allowing light and radiant heat to pass through, trapping the heat within. This was particularly useful for over-wintering tender plants. By the end of the 18<sup>th</sup> and start of the 19<sup>th</sup> century the south facing walls of Padua Botanic Gardens had temporary lean-to glazing. This comprised a timber-framed circular structure that fixed back to the encircling wall. The pitch was to the rear, allowing for maximum vertical glazing to the sunny side throughout the winter. A more permanent structure was erected along the north boundary of the site, where plants could live all the year round in conditions similar to that of their original habitat. Complete enclosure enabled much more control. As back-up to the south-facing glazing furnaces were built behind the rear wall to provide heat when required.



**Figure 6** Padua Botanic Gardens with winter glass protection

An increasing interest in horticulture, led to the development of plant collections and to changing ideas of classification, creating the necessity to house them scientifically. Botanic gardens not only expanded but their purpose broadened. They could no longer be contained within the confines of the original walls. There was also an increasing desire to over-winter plants from abroad, and pressure to keep alive the trophies that had been collected from all corners of the world [6]. The old universities acquired more land beyond the confines of the already established *hortus conclusus* to house growing collections. Individuals and corporations as well as universities were making collections. Gardens such as Kew, not attached to a university, developed in areas outside the metropolis where there was less pressure on the land. This allowed greater freedom of

expression for developing areas where entire habitats could be contrived.

Garden design was by now radically altered, and this influenced the layout of botanic gardens. The new layouts attempted to recreate particular locations on the globe, allowing for plants to be observed as far as possible in a re-creation of their natural habitat. The garden tried to mimic nature. At the University of Padua the extended garden, an arboretum, was designed in the 'English style.' Rigid geometry was cast aside in favour of more 'natural' meandering paths, going so far as to create a small artificial hill, the Belvedere, within the grounds to the south. Now we see an idealised nature wrapping around an enclosure containing a different representation of ideal Nature. We have a garden within a garden. The paradise garden is no longer a safe haven from the wilderness of the growing city; it has become a retreat from the artificial forest created by the arboretum.

Kew Gardens in England covered a large area, now 132 hectares, where there was space for experimentation. Here the development of habitats was ambitious. The most extreme of these was achieved by creating a totally artificial environment with the aid of glass and cast iron.

## THE GLASS HOUSE, A NEW PARADISE

### ORIGINS

A radically new building form developed out of four chief influences: wealth, scientific advance, technology, and leisure. Botanical interests had spread beyond the universities. There was a growing number of landowners who wished to display acquisitions from their travels abroad. These trophies, especially if they were exotic plants, needed a new type of specialised environment to sustain and display them. There was increasing interest in the understanding of nature through classification and botanic gardens were laboratories to carry out these investigations. The Industrial Revolution had heralded the breakthroughs in both glass and cast iron technology that revolutionised architectural design. A new freedom of movement due to increasing public transport and enjoyment of public life made it possible for the growing middle classes to visit gardens such as Kew. Demand increased rapidly. Paradise now incorporated both the exotic and the idea of spectacle.

Out of this rich mix a new type of glasshouse emerged. Michael Wigginton describes this new fusion of iron and glass: "Together these combined to give a new architectural syntax: the fine, light-transmitting frame, working with the idea of stressed skin, showing the potential of the new glass architecture freed from the baggage of conventional architectural form" [6]. Not surprisingly, glass houses were developed in Northern Europe where there was a greater need for warmth [7]. The glass house managed to combine two aspects of gardening: overwintering of tender plants and the possibility of growing plants out of season as well as out of place. The interest and delight in the exotic could now be celebrated through the architecture of the enclosure, impressive enough to dignify the magnificence of the

plant collection. This architectural possibility so captured the imagination of the early designers of glass houses that a new type of building emerged, no longer needing to reflect the architecture of the houses to which they were attached. Large open interiors could be constructed to create much grander artificial environments. They were light, and being freestanding could provide maximum solar gain throughout the day.

As an example, I wish to look at the Palm House at Kew, constructed between 1845-8. Much has been written about it and the technical brilliance of its designers, Richard Turner and Decimus Burton so I will not go into detail about the construction. Within the theatre of the gardens the Palm House now takes centre stage, placed where it can be seen as a grand pavilion, a gathering and focal point within the 132 hectares of grounds at Kew. Aben and de Wit call this enclosed garden 'condensed nature' [8].

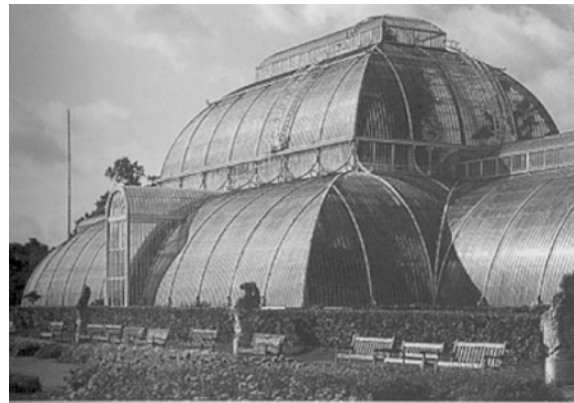


Figure 7 The Palm House Kew Gardens

The pavilion now allows for the indoors to become an artificial outdoors, controlled, and concentrated for us to feel wonder and be entertained, as well as being a botanical laboratory. Despite its transparency it provides an enclosed safe space for plants and people. In our temperate climate, when the weather for much of the year is inclement, we can go to a safe haven where the controlled atmosphere provides optimum conditions for both the plants and their observers. We can also indulge in the sensuality of the luxuriant growth of tropical plants, their sensational scents and colour. It has even been suggested that birds be introduced to complete the experience. Alfred Wallace suggested that it would be an ideal habitat for birds of paradise [9] The Palm House expresses both the curving fronds of the palms and ferns within it, and the optimism even the extravagance of the period.

### CONTEMPORARY DESIGN

As well as using glass for modifying an internal environment, the use of mass has become important once again with the newly opened Alpine House at Kew, designed by architects Wilkinson Eyre. This relatively modest building, in contrast to the Palm House, exemplifies the use and enhancement of naturally occurring phenomena to create an exacting

artificial environment, that could only have been achieved with the use of sophisticated software programming, and technological advances in both the structure and cladding. The Alpine House contrasts with the Palm House through its contents and climatic conditions it sets out to create. Within the Palm House the luxuriant plants, and high humidity envelop one. The observer is barely conscious of the light, curving frame of the outer glazed skin, echoing the natural in an almost Ruskinian manner. As with the Palm House, this aesthetic evolved out of the exacting internal climatic requirements of the brief: to create a cool environment that requires an optimum amount of light. As Peter Campbell suggests, when this is done well it "will come closer to making architectural poetry" [10]

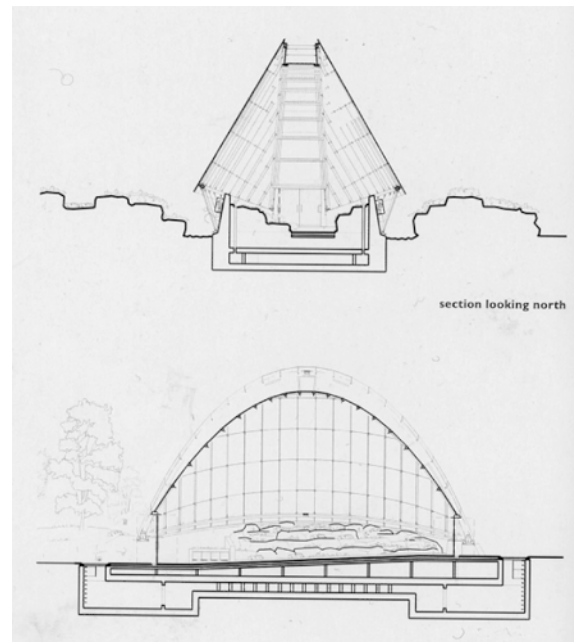


**Figure 8** The Alpine House Kew Gardens

Plant houses must keep the artificial weather in and the external weather out. Wilkinson Eyre has achieved this through almost imperceptible means. There is no whitewashing of panes, or noisy cranking of ventilators as they open and close. Air is drawn underground by a small fan into a labyrinth of pipes embedded in concrete, which acts as a heat sink and stays at a constant cool temperature. This cooled air is brought in to the planted area, and is distributed through vents around the plants. Height is essential to create a stack effect. Warmed air rises up and is drawn out of vents at the top, and this helps draw the air from the below through the glasshouse. The building has a North/South orientation enabling the sides to have an evenly distributed amount of morning and afternoon daylight. The East and West flanks are also curved to deflect excess solar gain. Each flat pane of glass is set at a different angle such that no more than one pane at a time receives direct sunlight, restricting solar gain over any large surface area. Internal fan-shaped blinds provide additional shade to help maintain coolness. The structure itself is has the delicacy of a dragonfly; the fanning out of the blinds has been called a peacock's tale [11].

Artificiality has been taken a stage further in the Alpine House. The plants do not stay there all the year round, they are brought in to flower and then whipped out again as they fade, to be replaced by the next batch of later flowering varieties. The show must go on inside the theatre of botanical wonders. The players come and give their best performance and

then vanish into the wings. Although we can be cynical about the garden as entertainment, it fulfils an important educational role.



**Figure 9** Sections through Alpine House

Where the Palm House could be seen to be profligate, it expressed an exuberance fitting with the times. The Alpine House expresses restraint and the result is a building with a very low energy output. Everything used is essential, reflecting our concern for economy of natural resources, and all this is held in tension with the knowledge that the design could only be achieved by using the most advanced technology in our culture.

## CONCLUSION

Botanic gardens still contain an imagined paradise at their heart, and some like Padua still remain a vivid reminder of what was called a search for paradise. The new development of the Alpine house at Kew reveals that the botanic garden can still offer new possibilities appropriate to the 21<sup>st</sup> century. Both the building and the environment within confront issues of sustainability and fragile bioclimatic conditions.

The role of botanic gardens continues to change. Increasingly it has become more an educational resource and pleasure garden rather than a botanical laboratory. Education and enjoyment go hand in hand. The spectacle helps draw people into the artificial environment of the garden, and once they are there the educational intentions can begin to be effective. It could seem that this aspect is extra to the display. Education is in fact key. Education and spectacle both have their roots in an underlying desire for a more utopian world that we saw in the paradise garden. In the 19<sup>th</sup> century the palm house could be seen as fulfilling a desire for paradise that had risen out of fears of the rapid growth of

industrialisation and the appalling conditions that came with it. In the context of contemporary concerns about climate change and damage to eco-systems, such environmentally utopian visions remain very potent and the botanic garden contributes toward visualising them.

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## ILLUSTRATIONS

- 1 Painting for the Mughal emperor Victoria and Albert Museum V& A Publications (2002), 90-91.
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- 3 Author
- 4 Author
- 5 Author
- 6 Engraving University of Padua
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