BIODIVERSITY STUDIES

Biodiversity Studies (BiSt)
2022, 1(2): 75-83
https://doi.org/10.56494/dnbgt.2022.10

REVIEW

A Review on Botanic Gardens

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How to cite: Demirel, Ö., Bingül Bulut, M. B. and Aydoğan, T. G. (2022). A Review on Botanic Gardens. *Biodiversity Studies (BiSt)*, *1*(2), 75-83.

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Article History:
Received: 12.12.2022
Accepted: 31.12.2022
First online: 13.01.2023

Keywords
Botanic gardens, conservation, functions, biodiversity

Abstract

Botanic gardens have changed over time, as have their uses and social roles. They were initially developed in the 16th century for the study of medicinal plants, but between the 17th and 19th centuries, they expanded to Asia, America and Africa; they turned into active sites for the introduction, cultivation and dissemination of economically significant plants. The necessity for biodiversity protection and sustainable use gained prominence in the 20th century. Botanical gardens are faced with the challenge of addressing problems that go beyond the confines of the garden by making social and environmental responsibility a primary focus of their missions. Therefore, to a better understanding of the role of botanic gardens and to highlight the importance of biodiversity, this study focuses on the historical development of botanic gardens and their functions and the current conditions of botanic gardens in Türkiye.

INTRODUCTION

Botanic gardens have seen as beautiful green areas with rare trees and flowers and a laboratory where experts work with plants. However, botanic gardens are more than these common perceptions and expected to fulfill requirements of their time (Brockway, 1979). The term botanic garden is a synonym of botanical research institute used in some places; Berlin, Kew, Geneva, Sydney (Raven, 1981), is clearly defined by the Botanic Gardens Conservation International (BGCI), the lead organization for the Global Strategy on Plant Conservation (GSPC), as "an institution holding documented collections of living plants for the purposes of scientific research, conservation, display and education" (Wyse Jackson, 1999, p.27).

The BGCI organization also defines the following criteria for a botanic garden; "a reasonable degree of permanence, an underlying scientific basis for the collections, proper documentation of the collections, including wild origin, monitoring and long term maintenance of plants in the collections, adequate labelling of plants, open to the public, communication of information to other gardens, institutions and the public, promoting conservation through extension and environmental education activities, exchange of seed or other materials with other botanic gardens, arboreta or research institutions, undertaking of scientific or technical research on plants in the collections including taxonomy, molecular biology, biochemistry, ecology, biodiversity conservation and other disciplines, conserving rare and threatened plants in *ex situ* collections (e.g. in the garden, seed banks etc.) and, wherever possible, in their natural habitats, compliance with international and national regulatory frameworks (e.g. the CBD, CITES, plant health, invasive species etc.), adoption and promotion of sustainable practices such as renewable energy, water conservation and waste recycling, adoption and promotion of ethical standards related to knowledge, data sharing, procurement, commercialization and

employment" (Smith and Harvey-Brown, 2017, p.5).

Since 1970s, it has been widely acknowledged that botanic gardens play a general role in plant conservation. Numerous threatened plant species now have well-documented living collections and seed banks (Oldfield, 2009). Moreover, botanic gardens have been served for different purposes around the world including the cultivation of trees, shrubs, and other kind of plants (dendrology, arboriculture, ornamental horticulture, floriculture, herbarium etc.), conservation biodiversity (gene banks, seed store and tissue banking, new crop genetic resource, habitat restoration, pest control management etc.), engagement with public (environmental education, library services and information centers, training and therapy, recreation, tourism etc.) (Wyse Jackson and Sutherland, 2000).

Activities at botanic gardens vary according to funding sources, capacity, location, governance and size (Williams *et al*., 2015). Based on establishment purposes botanic gardens can be at different types as traditional with a multi-disciplinary garden, ornamental gardens, historic gardens, conservation gardens, university gardens, combined botanical and zoological gardens, agro-botanical and germplasm gardens, alpine or mountain gardens, natural or wild gardens, horticultural gardens, thematic gardens, community gardens (Wyse Jackson and Sutherland, 2000).

In this study, it is aimed to focus on the historical development of botanic gardens and their functions. To create a common sense that highlights the importance of biodiversity, current conditions of botanic gardens in Türkiye is also emphasized.

Historical Development of Botanic Gardens

The first formation of botanical gardens was seen in the world before 16th century as plant collection gardens (O'Donnell and Sharrock, 2018). They were generally located in a private home garden and used to include a variety of therapeutic plants that were gathered from the wild (Rae, 1996). During the 16th and 17th centuries, universities established plant gardens for teaching medicine and those gardens formed today's botanic gardens. The oldest university gardens in Europe are Pisa and Padua (Padova) established in Italy in 1544 and 1545 (Figure 1). In France, the oldest botanic garden, the Jardin des plantes de Montpellier was established in 1593. In the United Kingdom, the oldest botanic garden is The University of Oxford Botanic Garden founded in 1621 (Figure 2) (Thorogood, 2022).

In the 17th and 19th centuries, botanic gardens spread to Asia, America and Africa, and became important centers for trading the seeds and fruits (Borsch and Lohne, 2014). In the 20th century, increased awareness of biodiversity loss and ecosystem services led to focus on the role of botanic gardens on conservation issues (Krishan and Novy, 2016). The focus of botanical gardens has shifted in the 21st century to ensuring relevance to communities and addressing their needs, both locally and globally (Wondafrash *et al*., 2021).

Recently, the GardenSearch Database developed by BGCI currently holds records on 3764 botanic gardens information all around the world including the well-known ones; Royal Botanic Gardens, Kew, England (1840) (Figure 3); Royal Botanical Gardens Sydney (1816); Singapore Botanic Gardens (1859), Munich

Figure 1. Historic Padua Botanical Garden (Retrieved from Cavaliere, 2008).

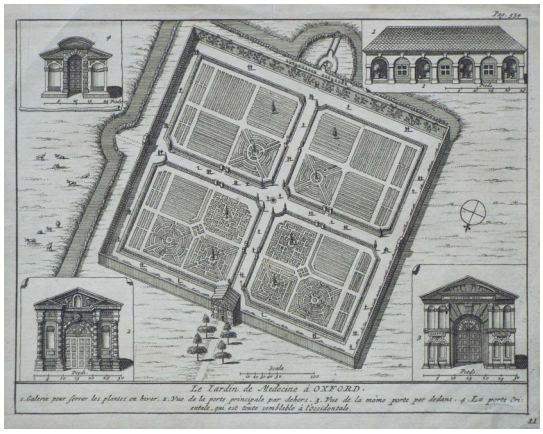

Figure 2. The University of Oxford Botanic Garden (Retrieved from: http://www.rareoldprints.com/p/19766).

Figure 3. Plan of the Royal Palace Gardens and Park at Richmond in 1754 (Retrieved from: https://www.kew.org/read-and-watch/kew-gardens-surprising-historical-facts).

Botanical Garden (1809); Kirstenbosch National Botanical Garden (1913); Montreal Botanic Garden, Canada (1931); Jardim Botânico do Rio de Janeiro, Brazil (1808), Brooklyn Botanic Garden, USA (1910). Throughout history, botanic gardens have played a variety of roles and continue to adapt to meet society's needs and meet new challenges. They are significant contributors to both the local and national economies because they are major tourist destinations that welcome an estimated 500 million visitors annually. They likewise give many advantages to society such emphatically affecting mental and actual wellbeing, especially in metropolitan settings where most of botanic gardens are arranged (BGCI, 2022).

Functions of Botanic Gardens

Botanic gardens are open-air museums or collections of plants where a wide variety of living and inanimate plant species are brought together, and they also serve as important parts of the urban green system that are open to the public. Botanic gardens basically have important functions in terms of scientific (conservation, climate change, food security etc.), educational (plant introduction, displays etc.) and recreational (health and wellness, exhibitions, horticultural therapy etc.) purposes (Krishnan and Novy, 2016). Although the botanical gardens in the world were initially established to introduce economic plants, especially medicinal plants, to the public and to conduct research on them, their functions have developed and diversified over time (Powledge, 2011). In the future, botanic gardens will be more specific and a part of other urban green areas such as public parks, urban forests and nature reserves (Heywood, 2017).

Botanic gardens serve a variety of purposes, but they have had a leading role in plant taxonomy, systematics and horticulture (Donaldson, 2009). They provide the opportunity to preserve plant diversity ex situ and play a significant role in the prevention of species extinction (Oldfield, 2009). If botanic gardens aim to preserve diversity as a major goal, they should set up seed banks (Raven, 1981). Seed banks are being established by botanical gardens to preserve wild plants (O'Donnell and Sharrock, 2017; Lupton *et al*., 2017).

Some of the world's largest and most sophisticated seed banks operate on a global and national scale within the community of botanic gardens. For instance, the Royal Botanic Gardens Kew's Millennium Seed Bank in the United Kingdom and the Royal Botanic Garden Sydney's PlantBank in Australia are examples of large-scale seed banks that are preserving local plant diversity on a national or regional scale (O'Donnell and Sharrock, 2017). Seed banking is progressively being utilized to monitor plant species, guaranteeing that material of such species is accessible for recuperation, renewed introduction and rebuilding programs (O'Donnell and Sharrock, 2017).

Wagner (1972) states that "a botanical garden with no research at all is little more than a kind of park; with research, such a garden develops a more profound significance to society" (p.6). One of the botanic gardens, The University of Wisconsin Arboretum, is often considered the birthplace of the concept of ecological restoration (Harwick *et al*., 2011). Botanical gardens can be particularly useful for

collecting long-term data on plant responses to environmental and climate change (Primack and Miller-Rushing, 2009).

Williams and her colleagues (2015) investigated an assumption that environmental education programs make, that increasing people's ecological knowledge will change their attitudes toward the environment. Seventeen UK botanic gardens were included in their study and results showed that environmental attitudes and ecological knowledge are strongly correlated, and botanic gardens can have a positive effect on environmental attitudes.

Botanic gardens offer a chance to be in a relaxing setting away from the pressures of modern life (Wassenberg, 2015). The reasons for visiting botanic gardens changed from simply seeing flowers to social, intellectual and personal needs. Studies on the reasons why people visit botanical gardens shows that family unity, learning, creativity, enjoying nature, escaping personal and social pressures, and escaping physical pressure are several visitor motivations (Manning, 1999).

According to Kohlleppel *et al*. (2002), Bennett (1995) and Owen (1994) botanical gardens offer experiences that can have a positive impact on the well-being of visitors and could be used as places to help people deal with stress. Kohlleppel and his collugues conducted study at Florida gardens including the Bok Tower Gardens, the Fairchild Tropical Garden, and the Mounts Botanical Garden; Bennett (1995) conducted at the Brooklyn Botanic Garden and the New York Botanical Garden; Owen (1994) conducted at the Wichita (Kansas) Gardens found that visitors had reduced stress levels after their visitation.

It is noteworthy that many of the botanical gardens, in addition to the recreation opportunities they have had in recent years, also include uses and organizations that will respond to the active recreation needs of the community (Connell, 2005; Wassenberg *et al.,* 2015). Several activities that will not contradict the primary purpose of the botanical gardens and will not override the botanical garden in terms of the use of space and uses, but rather meet the needs of the visitors during their visits to the garden and renew themselves, can be included to a limited extent. With the increase in the number of activities such as eating more and drinking tea and coffee, the size of the area it will occupy may pose a risk and threat to the botanical gardens (He and Chen, 2012).

Botanic Gardens in Türkiye

Botanic gardens in Türkiye were first established for the cultivation of fruits, vegetables and especially medicinal plants during the Byzantine and Ottoman Empire periods (Müminoğlu *et al*., 2018). The first botanic garden in a modern sense is the Galata Palace Botanical Garden, which was founded in 1839, next to the 'Mekteb-i Tıbbiye-i Şahane' building, which was established on the site of today's Galatasaray High School (Müminoğlu *et al*., 2018).

İstanbul University Alfred Heilbronn Botanical Garden (AHBG), which was founded in 1935, is the oldest botanical garden in Türkiye (Müminoğlu *et al*., 2018). AHBG also has an herbarium, seed bank, botanical library and botanical research laboratories (Akkuş, 2013). Atatürk Arboretum, which was accepted to be established in 1949 by Forestry Management National Agency, was officially named as Atatürk Arboretum in 1982. The arboretum was established on an area of 296 hectares in the southeast of the Belgrad Forest in Sarıyer district (OGM, 2022). It was planned to be an arboretum predominantly oak and Fagaceae family because of the abundance of naturally grown oak taxa in our country and the fact that the Belgrad Forest is quite suitable for oaks (Sertkaya, 1997). Ege University Botanical Garden and Herbarium Center was established in 1962. In addition to its research and educational services, the botanical garden is an important institution to raise awareness among the public for the conservation of biodiversity (Özgenç, 2019).

Çankaya Botanical Garden was planned to be established in 1970 on an area of 60 decares with the cooperation of Ankara University Landscape Architecture Department and Ankara Municipality Gardens and Parks Directorate. The botanic garden was planned and designed by Prof. Dr. Yüksel Öztan in 1972 to meet the cultural and recreational needs of the people (Ekim, 1991). Öztan and his colleagues (2001) states in their research 'Evaluation of Ankara City Valleys in Terms of Conservation Usage Principles: Example of Imrahor Valley' Çankaya Botanical Garden is one of the areas considered within the urban green space system in the '2015 Structural Plan Proposal' carried out in 1986 in cooperation with the METU City and Regional Planning Department and the Municipality. Today, the garden serves as a botanic park.

Karaca Arboretum is located in Yalova province, was first arranged as a home garden in 1978 and transformed into the Arboretum in 1980 by Hayrettin Karaca (Şat, 2002).

Anatolian Botanical Garden was planned to establish in 1993 according to the contract signed between the Ministry of Environment and Ankara University Institute of Science and Technology. In 1994, the garden was designed by Prof. Dr. Yüksel Öztan and Prof. Dr. Halim Perçin for the protection and development of flora and fauna in the area (1350 decares), based on a mixed system that will increase the love of nature and meet the recreational needs of the people, but the project has not been implemented (Ölçal, 2003).

Nezahat Gökyiğit Botanical Garden (NGBG) was established in 1995 by Ali Nihat Gökyiğit in order to create a memorial park in the name of his wife Nezahat Gökyiğit, and in 2003, its name was changed to Nezahat Gökyiğit Botanical Garden (NGBG, 2022). The botanical garden, established on an area of 32 ha, consists of 8 islands and provides different educational, recreational and research activities (Karaşah and Var, 2016).

Süleyman Demirel University Botanical Garden gained its legal identity in 1998 (Özçelik *et al*., 2006). Gaziantep Botanic Garden was founded in 2009. Konya Tropical Butterfly Garden, Türkiye's first butterfly garden and Europe's largest butterfly flight area, was founded in 2015. Ata Botanic Garden, which is 350 acres, is 1850 m above sea level. It is located in the city center of Erzurum, on the high ground and on the territory of Atatürk University (Müminoğlu, 2018). Zeytinburnu Medicinal Plants Garden is Türkiye's first medicinal plant garden founded in 2005. In the garden there are more than 700 medicinal plants laid out 14 acres area. This medicinal garden encourages the cultivation of medicinal plants, promotes the effective and safe use of medicinal plants as well as researching, propogating, promoting medicinal plants (ZMPG, 2023).

National Botanical Garden of Türkiye started to establish in 2012 on an area of 220 hectares in Lodumlu District in Çankaya, Ankara. Throughout the history the area of the botanic garden serves as the 'Soil Conservation Research Station' in 1962, the 'Central SoilWater Research Institute' in 1966, the 'Ankara Research Institute of Village Services' in 1985, and the 'Ankara Soil-Water Central Research Institute' in 2005, where various research and applications were carried out. (Çimen, 2019). The first arboratum in Ankara was established in this area (Çimen, 2019; Resne Okan, 2022).

The National Botanical Garden Directorate was established in 2011, and the design and implementation of the Botanical Garden is carried out by the General Directorate of Agricultural Research and Policies, the Central Organization of the Ministry of Agriculture and Forestry (Çimen, 2019; Resne Okan, 2022).

Botanic gardens mentioned above are the well-known gardens in Türkiye and most of them listed on the database of the GardenSearch (Table 1). However, information about the gardens is very limited.

In some botanic gardens mentioned above, researchers have carried out studies regarding on different aspects of botanic gardens.

Table 1. Botanic Gardens in Türkiye based on the GardenSearch Database, BGCI, 2022.

Name of the Botanic Garden	Location
Ali Nihat Gökyiğit Botanic Garden	Adana
İstanbul University Alfred Heilbronn Botanical Garden	İstanbul
Ege University Botanic Garden and Herbarium Research Center	İzmir
Atatürk Arboretum	İstanbul
Ankara University Botanic Garden	Ankara
Karaca Arboretum	İstanbul
Nezahat Gökyiğit Botanic Garden	İstanbul
Süleyman Demirel University Botanic Garden	Isparta
Gaziantep Botanic Garden	Gaziantep
Malva Permaculture Farm	İstanbul
Sultançiftliği Farm	İstanbul
Konya Tropical Butterfly Garden	Konya

Karaşah (2014) conducted a study at the Nezahat Gökyiğit Botanic Garden (İstanbul) and Royal Botanic Garden (Edinburgh) for assessment of visual landscape preferences. The study showed that culture play important role in perception of landscape and users' expectations, their visiting purposes and spatial-seasonal preferences affects their perceptions.

Ünlü (2016) proposed a revised plan includes plant collections such as medicinal garden, discovery garden, sensory garden, and including the local plant material to use for the Süleyman Demirel University Botanical Garden.
In the study of 'Studies on the Biotopes of National Botanic Garden of Turkey', Çimen (2019) identified 14 biotopes including afforestation area, wetland, meadow area and orchard, arboretum, and garden. He also emphasized the importance of determining the criteria for determining the ecological-based landscape planning studies and giving direction to development policies.

Musdal (2019) carried out a study on the planning and design principles of botanical gardens in the example of Nezahat Gökyiğit Botanical Garden. Gökkaya (2021) makes a medical and aromatic garden landscape design proposal for the 750 m^2 area determined in Atatürk University Botanical Garden.

Gemici (2022) conducted research on whether landscape areas have a positive and negative effect on human psychology in the Nezahat Gökyiğit Botanical Garden. In his study on 96 people, he determined that the depression, anxiety and stress levels in the whole area decreased after sitting in the area for half an hour with the tests made at the first entrance to the garden.

Resne Okan (2022) proposed sustainable planning and design criteria of botanical gardens from the example of the Turkish National Botanical Garden in her thesis study. These criteria are discussed under 6 main headings: structural landscape design, herbal landscape design, administrative planning, spatial planning, educational, social, and cultural planning, and management and maintenance. The National Botanical Garden of Turkey received a total of 59 points out of 100 from the criteria of sustainable planning and design. According to the scoring, it was evaluated that TNBB is quite strong in spatial planning but weak in educational, social and cultural planning.

Yardimci (2022) developed an edible landscape design proposal in the botanical garden of Ataturk University. With the edible landscape design proposal for the 1500 m^2 area, it is aimed to raise the awareness of the public, to increase the environmental quality, to create livable spaces, to contribute to the provision of food safety and flexible food systems.

RESULTS and DISCUSSION

Botanical gardens are unique public green spaces as they are perceived as "shop windows of biodiversity" (SANBI, 2006, p.28). As mentioned previously, botanic gardens have different responsibilities including production, conservation, science and research. Today, the key roles of botanical gardens are shaped by the following concepts: horticulture, protection, research, education and recreation. Before the establishment of the botanical garden, it is important to determine the purpose of the garden in the context of social and ecological needs.

Botanical gardens are a large settlement consisting of many gardens. Gardens can be visually enriched with many different applications. Garden art applications (French, Japanese, British, Renaissance and Turkish Gardens) belonging to countries that have a unique place in the history of garden art can be included as well as many different thematic plant application studies. It is also important to ensure harmony (mass, volume, surface) between the sections that make up the garden. However, in addition to these functions, especially in recent years, it is seen that the recreational dimension of botanical gardens, that is, the dimension of recreation and entertainment, is gaining importance and these issues are emphasized sensitively in planning and design studies. All botanic gardens, does not matter of size, should have strategic plans. Such documents are important for informing people what you do and are essential management tools for any organization (Wyse Jackson and Sutherland, 2000).

Botanic gardens are important scientific, cultural, and aesthetic entities that serve our society and thus, need to be managed in a sustainable way (Hulme, 2011). In the twenty-first century, gardens will be essential to solving challenges like climate change, food security,

biodiversity protection, environmental education, sustainability, and human well-being. Gardens will be required to address problems that go beyond the garden's boundaries to achieve these extended mission areas by making social and environmental responsibility important institutional purpose drives.

A multidisciplinary professionals will be needed for this. Additionally, to maximize the beneficial effects of botanic gardens on society, new strategies for recruiting and producing funding as well as other resources will need to be created. Botanic garden networks on a global, national and regional scale will be crucial in creating a hub for knowledge sharing. Botanic gardens have great prospects in the twenty-first century to play a significant role in addressing societal concerns that have a positive impact on communities.

The most important point to be considered here is the necessity of making "common mind" dominant in this work, as in all studies. Only with common sense, "common benefit" can be reached. As can be seen, the concept of botanical garden, which offers a great diversity and richness, is a planning element that needs to be considered in detail and it is a phenomenon that requires the coexistence and cooperation of many different professional disciplines that are directly or indirectly related to the subject.

Before carrying out design and planning studies for these areas, it is necessary to establish a planning and design team that consists of different professional disciplines and start by constructing a wide research framework based on social researches that measure the expectations of the public from the field from the analysis of physical data and then to inform all segments, when necessary, by making a scientific critique of the work done with feedback and monitoring. While defining the new face of the city, all professions dealing with urban science and planning share an opinion in line with the necessity of creating, protecting, and sustaining the natural elements that are directly related to the biodiversity and human life in rural areas in urban areas as well. Planners, architects, and engineers are expressing louder that they must seriously reconsider their design and production paradigms in the cities of the century they live in, and they admit that they must understand each other more.

ADDITIONAL INFORMATION

This research was presented at the 1st International Symposium of Biodiversity Studies and was published in the abstract e-book in the proceedings of the Symposium.

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