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The potential of Bursa city parks to provide natural food for urban wildlife

Bursa kent parklarının kentsel yaban hayatına doğal besin sağlama potansiyeli

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Abstract

This study aims to determine the periods during which fruit-bearing woody plant species in the study area parks have ripe fruits, thereby revealing the potential of these parks to provide food resources for urban wildlife. The study was conducted in three major parks in Bursa: Reşat Oyal Culture Park, Soğanlı Botanical Park and Hüdavendigar City Park. To determine the periods and durations during which each plant species bears ripe fruits, the study area parks were visited once a week for one year. During the visits, the times when the fruit-bearing woody plant species had ripe fruits were recorded on a species-time table. Reşat Oyal Culture Park hosts 32 species of fruit-bearing woody plants, Soğanlı Botanical Park has 35 species, and Hüdavendigar City Park hosts 17 species. The oldest park, Reşat Oyal Culture Park, has the highest number of native fruit-bearing plant species with 18, while the newest park, Hüdavendigar Urban Park, has the lowest number with 8 species. On a weekly average, 7.9 plants in Reşat Oyal Culture Park, 9.6 plants in Soğanlı Botanical Park, and 4.8 plants in Hüdavendigar City Park bear ripe fruits. A statistically significant difference was found between the data from Reşat Oyal Culture Park and Soğanlı Botanical Park compared to the data from Hüdavendigar City Park ($P>0.05$). In urban ecosystems, fruity woody plants provide natural food for urban wildlife. The use of native and fruit-bearing woody plant species in urban plantings has an important role in the sustainability of urban wildlife.

Özet

Bu çalışmada, çalışma alanı parklarda bulunan meyveli odunsu bitki türlerinin olgun meyve bulundurduğu zamanlar bulunarak, parkların kentsel yaban hayatı için besin tedarik edebilme potansiyellerinin ortaya koyulması amaçlanmıştır. Çalışma Bursa'nın üç büyük parkı olan Reşat Oyal Kültürparkı, Soğanlı Botanik Parkı ve Hüdavendigar Kent Parkı'nda yürütülmüştür. Tür bazında bitkilerin yılın hangi döneminde ve ne süre ile olgun meyve bulundurduğunu bulmak için çalışma alanı parklar 1 yıl boyunca haftada 1 kez ziyaret edilerek, parklarda bulunan meyveli odunsu bitki türlerinin olgun meyve bulundurdukları zamanlar tür-zaman çizelgesine işlenmiştir. Reşat Oyal Kültürparkı'nda 32, Soğanlı Botanik Parkı'nda 35, Hüdavendigar Kent Park'nda 17 meyveli odunsu bitki türü vardır. En eski park olan Reşat Oyal Kültür Parkı, 18 tür ile en yüksek meyveli doğal bitki türü sayısına sahipken, en yeni park olan Hüdavendigar Kent Parkı ise 8 tür ile en düşük doğal bitki türü sayısına sahip parktır. Reşat Oyal Kültür Parkı'nda haftalık ortalama 7.9 bitkide olgun meyve bulunurken, Soğanlı Botanik Parkında 9.6, Hüdavendigar Kent Parkında ise 4.8 tür bitkide olgun meyve bulunmaktadır. Reşat Oyal Kültürparkı ve Soğanlı Botanik Parkının verileri ile Hüdavendigar Kent Parkının verileri arasında istatistiksel olarak anlamlı bir fark vardır ($P>0.05$). Kentsel ekosistemlerde meyveli odunsu bitkiler kentsel yaban hayatına doğal besin sağlarlar. Kent bitkilendirmelerinde doğal ve meyveli odunsu bitki türlerinin kullanımı, kentsel yaban hayatının sürdürülebilirliği için kritik öneme sahiptir.

INTRODUCTION

The natural food sources of wild animals, particularly birds, in urban areas are diminishing by the day. With urbanization, based on the perception that all green spaces possess biodiversity (Lepczyk et al. 2017), the planning, management, and preservation of urban green areas formed by natural, semi-natural and artificial ecological systems play a critical role in preserving natural biodiversity (Aronson et al. 2017). Biodiversity in urban environments, which enhances well-being through improving air and water quality, aesthetic pleasure, and recreation (McKinney 2008), also plays a significant role in educating the increasingly urbanized population about nature and species (Miller and Hobbs, 2002). To achieve biodiversity goals, it is essential to specify and prioritize the needs (Lautenschlager 1997).

Urbanization, one of the human activities leading to habitat loss (McKinney 2002), is the most common cause of species extinction (Czech et al. 2000) and results in the extinction of most natural species (Marzluf 2008, McKinney 2008). The species that thrive in these areas due to human activities are often non-native species (MicKinney 2002, Miller 2002, Turner 2004, McKinney 2006, Lepczyk et al. 2017). Based on the wildlife studies literature investigating changes in biodiversity due to urbanization, it is conceivable that native species are more suitable for restorative efforts in urban green spaces (Nielsen et al. 2014). High-quality habitats are typically composed of native species (Terman 1997). Planting with native species contributes not only to the natural plant population but also to the natural animal population (McKinney 2002). There is a positive correlation between the diversity of natural vegetation and natural bird diversity (Munyenyembe 1989, Gallinat et al. 2020). Some native fruit-bearing shrub species are nutritionally high quality compared to invasive plants during the fall migration of songbirds (Smith et al. 2013). Non-native and invasive plant species negatively affect the diversity of native plants, as well as bird and butterfly communities; thus, the type of vegetation in urban environments is crucial (Dures and Cumming 2010, Felappi 2020). Using native plant species in urban landscaping is also an indicator of a community's effort to preserve its own culture and nature (Yılmaz 2014). People interacting with high levels of local diversity tend to have a stronger sense of place and belonging (Lerman and Warren 2011).

Plants and birds have mutually adapted to each other over the course of their evolution. The size, color (Willson and Whelan 1990, Schmidt 2004), and nutritional content of fruits have evolved to facilitate their dispersal by specific bird species, while the beaks, digestive systems, and other characteristics of birds have adapted to efficiently gather, ingest, and digest these fruits (Howe 1986, Snow and Snow 1988). Certain woody species are used in urban and rural landscape projects not only for their aesthetic value within the seasonal cycle but also because their fruit characteristics contribute to the diet of various organisms, thus maintaining ecological balance and ensuring sustainability (Kılıç 2016). Food is one of the most important factors for bird survival in cities; the peak of bird migrations is when the ripe fruits on plants are at their peak (Thompson and Willson 1979). While non-migratory birds require a year-round food supply, it is essential to provide food for migratory birds during their stay in the city (Hail and Kavanagh 2013). Besides plant diversity, the horizontal and vertical complexity of vegetation is also beneficial for animal populations (Gaston and Gaston 2010, Hail and Kavanagh 2013, Felappi et al. 2020). As urbanization increases, bird species richness decreases (Melles et al. 2003); hence, fruit-bearing shrubs and watercourses are particularly important for enhancing bird populations (Jacobs et al. 2009, Jarvis 2010). Parks, as indicators of urban biodiversity, play significant ecological roles in contributing to urban wildlife. The diversity of bird species in urban areas tends to be proportional to the density of vegetation (Lancaster and Rees 1979). The selection of plant species also impacts bird diversity; evergreen plants are crucial for providing nesting sites, while fruit-bearing plants attract frugivorous birds, especially during winter. Shrubs provide many bird species with both food and nesting sites (Savard et al. 2000).

This research focused on the ripe fruiting times of urban plants, which have not been discussed in the literature so far, and aims to make a unique contribution to the ecological functions of urban green areas from urban wildlife perspective.

This study was conducted in three major parks in Bursa: Reşat Oyal Culture Park, Soğanlı Botanical Park, and Hüdavendigar City Park. The fruit-bearing woody plant species used in the parks' plant designs were identified, and the periods during which these plants bore ripe fruit over the course of a year were determined. Based on the collected data, the study aims to determine during which weeks of the year and with how many different ripe fruit species the parks have the potential to provide food for urban wildlife.

MATERIALS AND METHODS

Study Area

Bursa province is located in the south of the Marmara Region, within the Susurluk basin, between 39° 35' – 40° 40' north latitude and 28° 10' – 30° 00' east longitude, and has a surface area of 1.104.301 hectares. Bursa province predominantly experiences a Mediterranean climate, characterized by dry, hot summers and mild, rainy winters. However, as one moves inland, away from the coastal influence, the climate gradually transitions into a semi-continental type. The region's average annual temperature is 14.4°C, with a relative humidity of 68.6% and an average yearly precipitation of 691.9 mm (Zencirkıran and Akdeniz 2017). This study was conducted in three major parks of Bursa;—Reşat Oyal Culture Park, Soğanlı Botanical Park, and Hüdavendigar City Park (Figure 1).

Figure 1. Study area parks; 1. Reşat Oyal Culture Park, 2. Soğanlı Botanical Park, 3. Hüdavendigar City Park

Reşat Oyal Culture Park, one of the oldest parks in Bursa, was opened in 1955 with the aim of integrating culture, nature, and urban life into a unified space. Spanning an area of 393.000 m², the park offers various recreational facilities, including an open-air theater, a pond, and numerous walking paths, making it a preferred destination for city residents. Soğanlı Botanical Park, established in 1998 and covering 400.000 m², serves not only as a recreational area but also as a center for botanical research and conservation efforts. The park hosts a diverse collection of plant species and thematic gardens, contributing to scientific studies and environmental education. Hüdavendigar City Park, which was opened in 2015 with a focus on promoting healthy living, is the largest urban park in Bursa, encompassing 510.000 m². The park features extensive sports facilities, including jogging tracks, football fields, and outdoor gyms, as well as playgrounds and picnic areas, offering a comprehensive space for both physical activity and leisure.

Data and Analysis

From the beginning of 2021 to the end of 2021, systematic observations were carried out in the study parks weekly. Fruit-bearing woody plant species used in the parks' plant designs are the main material of the study. During the field studies, the woody plant species with fruit-bearing characteristics in the parks were identified first. The weeks in which ripe fruits were observed on the plants were recorded in the species-time table regardless of the number of ripe fruits. According to the species-time table, data were obtained for each park on the number of fruit-bearing woody species, "the weekly average number of species with ripe fruits", and "the average duration that species bore ripe fruits". The parks were compared in terms of "duration of species bearing ripe fruits" and "weekly number of species with ripe fruits" by analyses of variance (ANOVA). The differences and groupings that emerged were identified using the Tukey test. Statistical analysis was carried out using the SPSS statistical package program.

RESULTS AND DISCUSSION

Fruit-bearing plants, which have played an important role in communities for centuries, are of great importance in creating sustainable green infrastructure systems in cities as they provide a food source for both wildlife and users in open green areas (Dikmen and Yılmaz 2021). Reşat Oyal Cultural Park hosts 32 different fruit-bearing woody plant species, Soğanlı Botanical Park 35 and Hüdavendigar City Park hosts 17 fruit-bearing woody plant species (Supplementary 1, 2, 3). Although the parks generally host similar species, each park has unique plant species that distinguish it from the others. When mutual species in the parks are excluded, there are 56 species varieties of fruit-bearing woody plants in Bursa's three major parks, 27 of which are native and 29 of which are exotic.

According to the species-time table, which indicates the period and duration during which species bear ripe fruit throughout the year (Supplementary 4), the average fruit-bearing period for plants in Reşat Oyal Cultural Park is 12.9 weeks, in Soğanlı Botanical Park it is 14.2 weeks, and in Hüdavendigar City Park is 14.5 weeks (Table 1).

Table 1. Average weekly number of species bearing ripe fruit

Study areas		**Native**	**Exotic**	**Evergreen**	**Deciduous**	**Total**
Reşat Oyal Culture Park	Species number	18	14	13	19	32
	Average fruit-bearing time (week)	13.9	11.5	16.2	11.4	12.9
Soğanlı Botanical Park	Species number	16	19	20	15	35
	Average fruit-bearing time (week)	15.5	13.1	19.5	11.4	14.2
Hüdavendigar City Park	Species number	8	9	9	8	17
	Average fruit-bearing time (week)	15.3	13.7	16.1	12.8	14.5
Total	**Species number**	**27**	**29**	**24**	**32**	**56**
	Average fruit-bearing time (week)	**14.6**	**13.6**	**17.7**	**11.3**	**14.1**

Due to various reasons, there is increasing interest worldwide in planting native species in urban areas (Doody et al. 2010). Native species are exceptionally adaptable to a variety of environmental conditions, including wet or dry weather, sunny or shady environments, acidic or calcareous soils, and both fertile and barren sites. Additionally, native plants contribute to wildlife habitats, require little maintenance, are suitable for all-season use, and provide viable alternatives for natural landscape planning. They are important in maintaining biodiversity and provide opportunities to incorporate regional characteristics into landscape design. Türkiye is a country rich in a wide variety of woody plant species. Türkiye hosts more than 700 native woody plant species in its flora (Irmak 2013). However, although Türkiye is one of the richest countries in Europe in terms of plant diversity, there is a tendency towards the use of exotic plant species instead of native plant species in landscaping studies (Güneroğlu and Pektaş 2022). Reşat Oyal Culture Park, one of Bursa's oldest parks, established in 1955, contains 18 native, 14 exotic, 13 evergreen, and 19 deciduous species of fruit-bearing woody plants.

Soğanlı Botanical Park, opened in 1998, hosts 16 native, 19 exotic, 20 evergreen, and 15 deciduous species of fruit-bearing woody plants. Hüdavendigar City Park, established in 2014, includes 8 native, 9 exotic, 9 evergreen, and 8 deciduous species of fruit-bearing woody plants (Table 1). Reşat Oyal Culture Park, one of Bursa's oldest parks, hosts the highest number of native fruit-bearing woody plant species among the study area parks. It has been observed that one of the native species southern nettle tree (*Celtis australis* L.) is extensively planted in that park. However, Hüdavendigar City Park, the newest of the study area parks, has the fewest native plant species as well as the fewest fruit-bearing plant species. Native plants have a longer average fruit-bearing period than exotic plants, and evergreen plants have a longer average fruit-bearing period than deciduous plants.

Seeds, fruits and acorns of forest trees such as walnuts, chestnuts, beeches and oaks are the preferred food of squirrels, while pine cones are the preferred food of squirrels, crossbills, woodpeckers and some other birds (Ayberk 2003). Fruit-bearing plants, particularly, play a crucial role in providing sustenance for songbirds. Species such as yew, holly, hawthorn, and ivy are essential food sources for birds like the blackbird, robin, and starling (Snow and Snow 1988). These plants contribute significantly to the diet of these avian species, particularly during seasons when other food sources are scarce.

In an environment where the problem of green spaces is increasing due to urbanization, one of the most valuable areas that users can have in many ways is edible gardens (Yalçınalp and Demirci 2018). Plants, which are at the base of the terrestrial food web, provide a wide variety of food sources for animals (Kissling et al. 2008). While ripe fruits can be found every week of the year in both Reşat Oyal Culture Park and Soğanlı Botanical Park, no plants bear ripe fruits in Hüdavendigar City Park during the 15th week of the year (Figure 2).

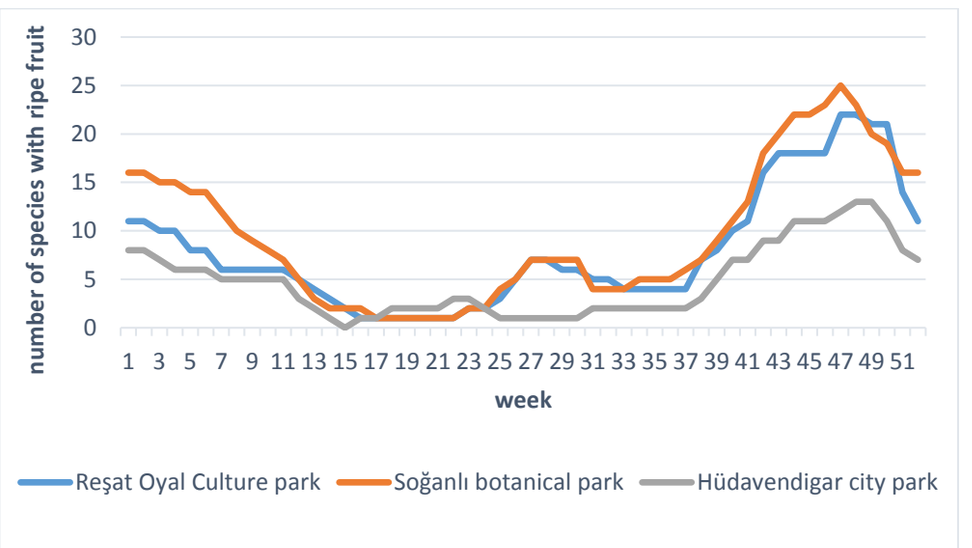

Figure 2. Weekly variation in the number of woody plant species bearing ripe fruits within the study area parks

The average number of fruit-bearing species in the three major urban parks that constitute significant green spaces in the city center of Bursa is 28. On average, there are 7.4 species with ripe fruits in the parks each week. The average duration for which these species bear ripe fruits is 13.9 weeks. Soğanlı Botanical Park has the greatest fruit diversity for the longest duration, followed by Reşat Oyal Culture park. There is a significant difference between the weekly number of species with ripe fruits in Hüdavendigar City park compared to the other parks (Table 2).

Table 2. Tukey test results of the weekly number of ripe fruit species and the duration of ripe fruit bearing among the study area parks

Study areas	Species number	Weekly number of ripe fruit species	Duration of bearing ripe fruit (week)
Reşat Oyal Culture Park	32	7.9 ± 6.1 a[1*]	12.9 ± 6.4 a
Soğanlı Botanical Park	35	9.6 ± 7.1 a	14.2 ± 6.9 a
Hüdavendigar City Park	17	4.8 ± 3.7 b	14.5 ± 6.5 a
Mean	**28**	**7.4 ± 6.1**	**13.9 ± 6.5**

*: [1]There is no statistically significant difference between values that share the same letter in the same column (P < 0,05)

Parks are an indicator of the biodiversity of cities (Gilbert 1989). There are 56 species varieties of fruit-bearing woody plants in Bursa's three major parks, 27 of which are native and 29 of which are exotic (Table 1). In several studies investigating plant diversity in residential areas, findings have indicated that certain landscape features enhance native bird diversity. To investigate urban food webs, a study of 12 residential gardens in suburban Pennsylvania, USA, half landscaped with native vegetation and the other half with exotic plants, found that gardens with natural vegetation harbored the highest numbers of butterfly larvae and insect-eating birds (Burghardt et al. 2009). For instance, in Hobart, Australia, it was observed that although native birds utilized gardens containing some exotic trees and shrubs, gardens with native plants had significantly more native birds compared to those landscaped with exotic plants (Daniels and Kirkpatrick 2006).

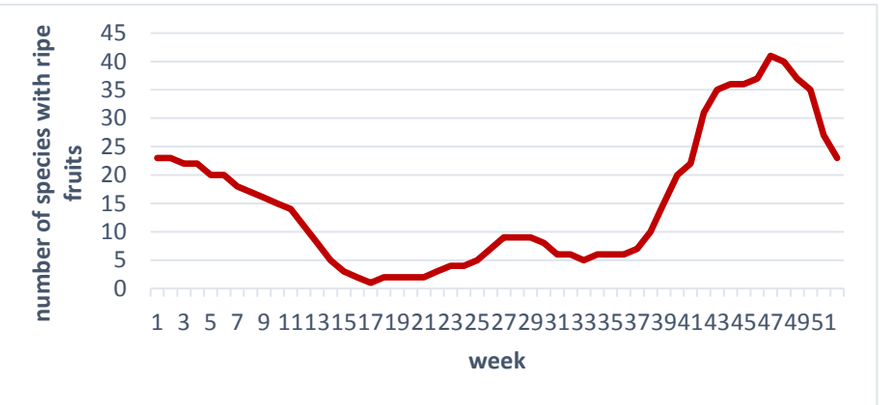

Figure 3. Total variation in the weekly number of ripe fruit species in the three parks

The 47th week, with 41 ripe fruit species, is the week with the highest diversity of ripe fruits in the study area parks (Figure 3). The 17th week, with only one plant species myrobalan plum (*Prunus cerasifera* Ehrh. 'Pissardii Nigra'), is the week with the lowest number of ripe fruits of the year. As a result of the co-adaptation of fruits and birds, the maturation of fruits varies according to the seasonal needs of birds. During the summer, when birds have the highest water requirements, fruits with a high water content are ripe. Conversely, in the winter, when birds' energy needs are greatest, fruits with the highest lipid content are ripe (Herrera 1982). In mid-summer, fruits with juicy structures particularly ripen, but their duration on the plants is not long due to their juicy nature. With the onset of autumn, in week 37, the number of species with ripe fruits in the parks increases rapidly. The total number of species with ripe fruits in Bursa parks reaches its peak in the last weeks of November, specifically in weeks 46, 47, and 48 (Figure 3). The duration of ripe fruit-bearing in evergreen plants is longer compared to deciduous plants (Snow and Snow 1988). When winter begins, in week 49, particularly due to the fruiting period of deciduous plants ending, the number of ripe fruits in the parks decreases. At the end of the year, in week 52, ripe fruits are on the plants in the parks a total of 23 plants, 18 of which are evergreen (Figure 3).

CONCLUSIONS

In this study, the fruit characteristics of woody plants used in the vegetative design of three major parks that constitute significant green spaces in the city center of Bursa were examined. The research determined the number of species and the duration of time during which these parks contained ripe fruits within a year.

Fruit-bearing plants that are unique in their ability to meet both ecological and social needs in urban landscapes; contribute to education, recreation, connection with nature, development of wildlife habitat and preservation of cultural identity (Walhowe 2022). Native and fruit-bearing plants play an important role in preserving biodiversity in the management of urban ecosystems. Differences have been found among fruiting woody plant species in the study area parks. The newest park among the study area parks, Hüdavendigar City Park, has the lowest number of native fruiting woody plant species. Although Türkiye has a rich diversity of native plant species due to its geographical location, exotic species are mainly used in urban landscaping. Native species are those that best adapt and thrive in their respective regions. In addition to their ecological functions, the use of native plants in urban landscaping would lend a distinctive character to cities that cannot be replicated elsewhere.

Although bird diversity in urban areas tends to be directly proportional to the volume of the existing vegetation, in park designs from past to present, the use of shrubs has significantly decreased due to various safety and aesthetic concerns. Shrubs, with their fruits and complex physical structures, create safe feeding and nesting areas for birds. To maintain the target level of biodiversity in urban ecosystems, mimicking nature in plant design through multi-layered plantings, where trees, shrubs, and herbaceous layers are interwoven, will ensure the support of different life forms by plants.

Based on the result of this study, parks should be evaluated according to the "Fruitfulness Index" and the importance of fruiting woody plants in vegetative design should be emphasized. The Fruitfulness Index can also draw attention to the existing contributions of parks to urban wildlife and biodiversity. For sustainable urban biodiversity, it is of great importance to prioritize the use of fruit-bearing and native plants in urban green areas and to select urban plants according to the feeding and nesting behaviors of animals.

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SUPPLEMENTARIES

Supplementary 1. Fruit-bearing plant species list of Reşat Oyal Culture Park

Latin name	English name	Fruit colour	Fruit size	Origin
Berberis thunbergii DC. "Atropurpurea"	Japanese barberry	Red	8-12 mm	E
Celtis australis L.	Southern nettle-tree	Brown-black	9-12 mm	N
Chamaerops excelsa Thunb.	Chusan palm	Black	8-10 mm	E
Corylus avellana L.	Common hazel	Brown-green	1-2 cm	N
Cotoneaster salicifolia Franch.	Willow leaf cotoneaster	Red	6-9 mm	E
Crategus monogyna Jacq.	Common hawthorn	Red	8-10 mm	N
Diospyros kaki L.	Kaki	Orange	5-8 cm	E
Diospyros lotus L.	Date-plum	Blue-black	1.5-2 cm	N
Eriobotriya japonica (Thunb.) Lindl.	Loquat	Yellow-orange	2-4 cm	E
Hedera helix L.	Ivy	Blue-black	6-12 mm	N
Juglans regia L.	Common walnut	Green	4-5 cm	N
Juniperus virginiana L.	Red cedar	Blue	3-6 mm	E
Laurus nobilis L.	Bay	Purple-black	8-12 mm	N
Laurocerasus officinalis M. Roem.	Cherry laurel	Black	8-12 mm	N
Ligustrum vulgare L.	Common privet	Black	3-8 mm	N
Malus floribunda Van Houtte.	Japanese crab	Yellow	1 cm	E
Melia azedarach L.	Chinaberry tree	Yellow	6-10 mm	E
Morus alba L.	White mulberry	White	1.5-2.5 cm	N
Olea europea L.	Olive	Black	1-3.5 cm	N
Parthenocissus quinquefolia (L.) Planch.	Virginia creeper	Blue-black	6 mm	E
Photinia serrulata Lindl.	Red robin tree	Red	3-5 mm	E
Prunus cerasifera Ehrh. "Atropurpurea"	Myrobalan plum	Red	1-1.5 cm	E
Prunus persica Mill.	Peach	Yellow-orange	5-10 cm	E
Prunus avium L.	Wild cherry	Red	8-10 mm	E
Prunus cerassus L.	Sour cherry	Red, black	6-8 mm	E
Punica granatum L." Nana"	Pomegranate	Reddish brown	6-12cm	N
Quercus robur L.	English oak	Brown	1.5-2 cm	N
Rosa sp.	Roses	Orange	1-2 cm	N
Rubus fruticosus L.	Bramble	Purple-black	6-8 mm	N
Sambucus nigra L.	Elder	Black	6-8 mm	N
Taxus baccata L.	Common yew	Red	8-10 mm	N
Vitis vinifera L.	Grapevine	Deep purple, blue	8-30 mm	N

N: native, E: exotic

Supplementary 2. Fruit-bearing plant species list of Soğanlı Botanical Park

Latin name	English name	Fruit colour	Fruit size	Origin
Aucuba japonica Thunb.	Spotted laurel	Red	1-1.5 cm	E
Berberis julianae Schneid.	Wintergreen barberry	Blue-black	6-9 mm	E
Berberis thunbergii DC. 'Atropurpurea'	Japanese barberry	Red	8-12 mm	E
Castanea sativa Mill.	Sweet chestnut	Brown	1.5-3.5 cm	N
Celtis australis L.	Southern nettle-tree	Brown	9-12 mm	N
Cotoneaster horizontalis Decne.	Rockspray cotoneaster	Red	5-8 mm	E
Cotoneaster salicifolia Franch.	Willow leaf cotoneaster	Red	5-8 mm	E
Crataegus oxyacantha L.	European hawthorn	Red	8-10 mm	E
Corylus avellana L.	Common hazel	Brown-green	1-2 cm	N
Cydonia oblonga Mill.	Quince	Yellow	10-12 cm	E
Elaeagnus pungens Thunb.	Thorny olive	Brown	1-1.5 cm	E
Hedera helix L.	Ivy	Blue-black	6-12 mm	N
Ilex aquifolium L.	Common holly	Red	5-8 mm	N
Ilex aquifolium L. 'Variegata'	Variegated English holly	Red	5-8 mm	E
Juglans regia L.	Common walnut	Green	4-5 cm	N
Juniperus virginiana L.	Red cedar	Blue	3-6 mm	E
Laurocerasus officinalis M. Roem.	Cherry laurel	Black	8-12 mm	N
Malus floribunda Van Houtte.	Japanese crab	Yellow	1 cm	E
Malus purpurea 'Eleyi'	Purple crab	Red	1 cm	E
Morus alba L.	White mulberry	White	1.5-2.5 cm	N
Morus nigra L.	Black mulberry	Red	2-3 cm	N
Photinia serrulata Lindl.	Red robin tree	Red	3-5 mm	E
Prunus ceracifera Ehrh. 'Pissardii Nigra'	Myrobalan plum	Red	1-1.5 cm	E
Prunus persica Mill. 'Cardinal'	Peach	Yellow-orange	5-10 cm	E
Prunus avium L.	Wild cherry	Red	1-2.5 cm	E

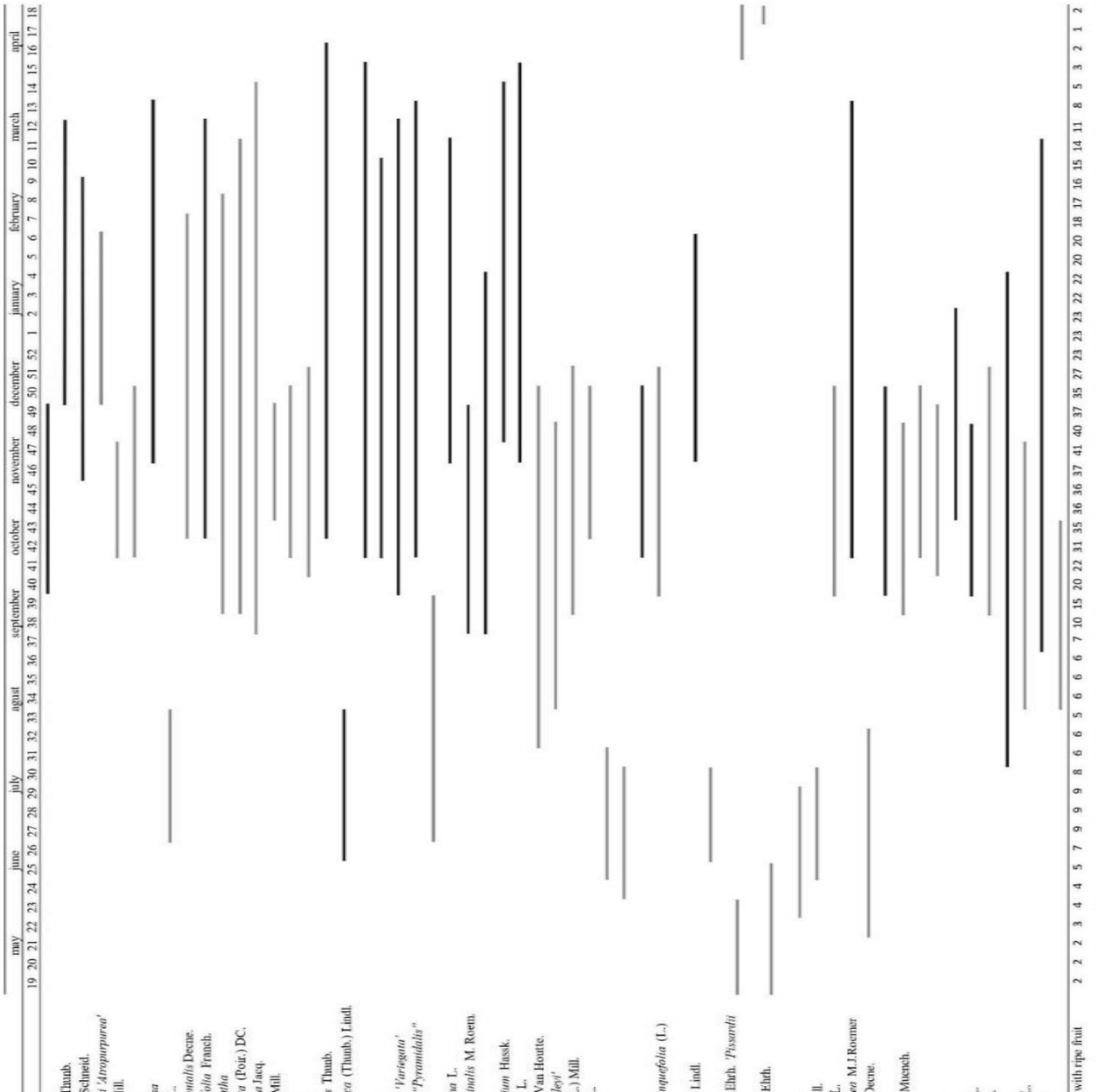
Prunus cerassus L.	Sour cherry	Red-burgundy	1-1.5 cm	E
Punica granatum L.	Pomegranate	Reddish brown	6-12cm	N
Pyracantha coccinea M.J.Roemer.	Scarlet firethorn	Red	5-7 mm	N
Quercus ilex L.	Holm oak	Brown	2-2.5 cm	N
Quercus palustris Muench.	Pin oak	Brown	1-1.6 cm	E
Quercus rubra L.	Northern red oak	Brown	1.5-3 cm	E
Rosa sp.	Roses	Orange	1-2 cm	N
Taxus baccata L.	Common yew	Red	8-10 mm	N
Viburnum opulus L.	Guelder-rose	Red	8 mm	N
Viburnum tinus L.	Laurustinus	Metallic blue	8 mm	N

N: native, E: exotic

Supplementary 3. Fruit-bearing plant species list of Hüdavendigar City Park

Latin name	English name	Fruit colour	Fruit size	Origin
Arbutus unedo L.	Strawberry tree	Red	1-3 cm	N
Berberis thunbergii DC. *"*Atropurpurea*"*	Japanese barberry	Red	8-12 mm	E
Crateagus leavigata (Poir.) DC. "Palu's Scarlet"	Midland hawthorn	Red	6-8 mm	E
Ilex aquifolium L.*"*Pyramidalis*"*	Common holly	Red	5-8 mm	N
Ligustrum ovalifolium Hassk.	Oval leaved privet	Black	3-8 mm	E
Malus sylvestris (L.) Mill.	Wild crab	Yellow-green	3-4 cm	E
Malus floribunda Van Houtte.	Japanese crab	Yellow	1 cm	E
Olea europea L.	Olive	Purple-black	1-3.5 cm	N
Photinia serrulata Lindl.	Red robin tree	Red	3-5 mm	E
Prunus cerasifera Ehrh. *"*Atropurpurea*"*	Myrobalan plum	Red	1-1.5 cm	E
Prunus cerasifera Ehrh. *"*Pissardi Nigra*"*	Myrobalan plum	Red	1-1.5 cm	E
Pyrus calleryana Decne.	Callery pear	Brown	1.5-2 cm	E
Quercus ilex L.	Holm oak	Brown	2-2.5 cm	N
Quercus robur L.	English oak	Brown	1.5-2 cm	N
Rosa spp.	Roses	Orange	1-2 cm	N
Taxus baccata L. *"*Pyramidalis*"*	Common yew	Red	8-10 mm	N
Viburnum tinus L.	Laurustinus	Metallic blue	8 mm	N

N: native, E: exotic



Supplementary 4. The species-time table shows the weeks during which fruit-bearing woody plant species in the study area parks have ripe fruits, evergreen plants are drawn in dark color