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The pollen calendar of the Emirgan grove, İstanbul (Türkiye)

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Abstract

Pollen calendars created for residential areas play a vital role in protecting and treating the sufferers of allergic diseases. In this regard, gravimetric and volumetric pollen traps are placed in the city and town centers. In process of creating the Emirgan Grove's pollen calendar, the gravimetric method was utilized together with the Durham sampler between March and September 2020. During this seasonal year, a total of 13464 pollen grains were recorded. According to the obtained pollen analysis results, the pollen grains of 44 taxa including 32 arboreal and 12 non-arboreal taxa were determined. Total pollen grains consisted of 90.95 % grains from arboreal plants, 9.05 % grains from non-arboreal plants. The period with the highest amount of pollen was detected as April. The taxon with the highest pollen concentration was *Pinus.* In terms of pollen concentrations, *Pinus* was followed by Cupressaceae, *Tilia*, *Abies*, Poaceae, *Prunus*, *Morus* and *Quercus* respectively. These genera have allergenic pollen, and therefore knowing their dissemination times are important for allergenic people living in the city. This study has been the first pollen calendar study conducted for groves and parks in Türkiye.

Keywords: pollen calendar, pollen grains, Emirgan Grove, *Pinus*, Durham sampler**.**

Introduction

Allergic diseases compose a significant group of diseases by affecting 20-30% of the population (Sin et al. 2007). One of the most crucial factors causing the emergence of these diseases is pollen. Pollen grains are known as "seasonal allergens" and are influential all year long due to their presence in the air for a long time. Pollens are powdery substances produced by flowers and are reproductive organs 5-150 µm in size, found in the flowers of trees, shrubs, and herbaceous plants.

Türkiye has a very rich vegetation diversity due to the variety in climate, geomorphology and soil characteristics along with embodying three different flora regions. According to recent studies conducted in the field, it has been detected that there are a total of 11559 flowering plant species in Türkiye, including naturally existing, cultivated and exotic species (Güner et al. 2012). Almost 20% of these species possess allergenic properties, which further increases the severity of pollen for allergic individuals (Sin et al. 2007). Therefore, pollen calendars are created by diagnosing and counting the quantity of pollen in the atmosphere on a daily, weekly, monthly basis, and the results are announced to the public through media organs in many countries.

Pollen calendars have an important role in treating the sufferers of allergic diseases. In this connection, gravimetric and volumetric pollen traps are placed in the city and town centers. The device called "Durham sampler" is utilized in the gravimetric method, and "Burkard Pollen Trap" or "Hirst Pollen Trap" is used in the volumetric method (Karlıoğlu 2011). In 1873, Blackley became the pioneer researcher who pointed out the presence of pollen in the atmosphere with the help of a simple pollen

trap. Thanks to these pollen traps developed by Durham (1946) and Hirst (1952), they pioneered several studies by making standard sampling and counting procedures comparable (Karlıoğlu 2011). The first atmospheric pollen analysis study in Türkiye was conducted by Aytuğ et al. (1966) in the Belgrad Forest, Istanbul. Following this study, many atmospheric pollen analysis studies have been carried out and many pollen calendars of different provinces such as Samsun (Yurdukoru 1979), Antalya (İnce and Pehlivan 1990), Ankara (İnceoğlu et al. 1994, Pınar et al. 1999), Bursa (Bıçakçı et al. 1999), Sivas (Pehlivan and Özler, 1995), Düzce (Kaplan and Serbes, 2004), Balıkesir (Bıçakçı and Akyalçın 2000); Burdur (Bıçakçı et al. 2000a), Isparta (Bıçakçı et al. 2000b), Denizli (Çelik et al. 2005; Güvensen et al. 2013); Çanakkale (Güvensen et al. 2005); Sakarya (Bıçakçı 2006), Kırklareli (Erkan et al. 2011), Kastamonu (Çeter et al. 2012), Mardin (Tosunoğlu et al. 2018) have been created accordingly. These studies have been conducted on a provincial or regional basis, but pollen calendars have not been created specifically for parks and groves up to now.

Within the scope of pollen analyses, the purpose of the study is to make a pollen calendar for the 25-week (March-September 2020) period of Emirgan Grove. Thanks to this pollen calendar, the best weeks in which guests with pollen allergy can visit the grove more healthily have been demonstrated. In addition, the weeks when the plants scatter more pollen and cause allergic reactions for the guests with pollen allergy visiting the Emirgan Grove were also detected in this study. This study has been the first pollen calendar study conducted for groves and parks in Türkiye.

Material and methods

Study site

Emirgan Grove is located in the north of Istanbul, in Sarıyer District of the province of Istanbul. It is located on the shores of the Bosporus, between Emirgan and Istinye districts. It is spread over ridges and slopes on an area of 47.2 hectares on the shores of the Bosporus (Fig. 1). There are a total of 211 different tree and shrub species in Emirgan Grove. A total of 9388 trees and shrubs belonging to these species continue to exist in the grove. The important trees of Emirgan Grove are; *Carpinus betulus* L., *Fraxinus angustifolia* Vahl, *Aesculus hippocastanum* L., *Platanus orientalis* L., *Platanus x acerifolia* Willd., *Quercus petraea* (Matt.) Liebl., *Quercus robur* L., *Quercus frainetto* Ten., *Quercus cerris* L., *Pinus pinea* L., *Pinus pinaster* Aiton, *Pinus brutia* Ten., *Pinus halepensis* Mill., *Tilia tomentosa* Moench, *Cedrus libani* A. Rich., and *Corylus colurna* L. (Akkemik et. al. 2021).

Figure 1. The location map of the study area.

Methods

In the process of creating the Emirgan Grove's pollen calendar, the gravimetric method was utilized together with the Durham sampler. The sampler device was placed on the roof of a building which is 2 m above the ground in the Emirgan grove, and the first glass slide was put into the device on 04.03.2020. After that, a thin layer of glycerin-gelatin was applied to the slides, and the slides were altered weekly. The last slide was taken out from the device on September 09.2020. The slides taken out of the device on a weekly basis were brought to the Palynology Laboratory in the Department of Forest Botany of Faculty of Forestry Istanbul University-Cerrahpaşa. In the laboratory, some glycerin-gelatin added onto the slides, heated with a heated on a hot plate, and covered with 24 x 50 mm coverslips, and the pollen preparations got ready for the pollen counting process.

Counting and identification of pollen grains in pollen preparations were performed via the computer-aided Leica DM750 branded light microscope, using x40, x100 immersion lenses and 10x ocular. For the pollen identification process, many pollen atlases (Wodehouse 1935, Erdtman 1952, Erdtman 1957, Faegri and Iversen 1964, Aytuğ, 1967, Aytuğ et al. 1971, Iwanami et al. 1988, Moore et al. 1991, Hesse et al. 2009) were used along with the reference pollen preparations in the Palynology Laboratory. Pollen counts were accomplished by scanning the entire coverslip surface from top to bottom in each preparation and counting the whole 12 cm^2 area. The numbers were converted to the amount of pollen per cm2, and the results were given as a percentage of pollen. Within the scope of the research, 25-week pollen data covering the March-September 2020 period of the pollen calendar study conducted in Emirgan Grove were presented.

Results

The identification of pollen grains belonging to a total of 44 taxa, 32 of which was arboreal and 12 of which was non-arboreal taxa, and the counting of 13464 pollens was carried out in total (Table 1).

In the pollen preparations of March, Cupressaceae, *Pinus, Alnus, Carpinus, Corylus*, Ericaceae, *Juglans, Populus, Quercus,* Rosaceae and *Ulmus* from the arboreal taxa; only the pollens of Asteraceae from the herbaceous taxa were detected. In this month, the highest percentage of pollen belonged to the Cupressaceae family (67.2%), and this was followed by *Fraxinus* (11.89%), *Carpinus* (7.62%), Rosaceae (6.52%), *Ulmus* (1.84%), *Alnus* (1.54%) and *Quercus* (1.10 %). Pollen percentage of *Pinus, Corylus*, Ericaceae, *Juglans, Populus* and Asteraceae was found below 1% (Table 1).

In the pollen counts of April the pollen grains of *Abies*, Cupressaceae, *Picea, Pinus, Acer, Aesculus, Carpinus, Corylus,* Ericaceae, *Euonymus, Fagus, Fraxinus, Juglans, Liriodendron, Morus, Paulownia, Platanus, Prunus, Quercus*, Rosaceae, *Salix* and *Ulmus* from the arboreal taxa; and the pollens of Apiaceae, Asteraceae, *Campanula, Cardamine* and Caryophyllaceae from the non-arboreal were identified. *Pinus* pollen (25.32%) was identified as the densest in April. Other significant arboreal taxa following *Pinus* in terms of pollen percentage were *Prunus* (11.99%), *Morus* (9.3%), *Platanus* (8.15%), *Juglans* (7.08%), *Acer* (6.83%), *Liriodendron* (5.2%), Rosaceae (3.51%) and *Carpinus* (2.78%). Pollen percentages of *Aesculus, Crataegus*, Ericaceae, *Euonymus, Fagus, Fraxinus, Paulownia, Quercus, Salix, Ulmus,* Apiaceae, Asteraceae, *Campanula, Cardamine* and Caryophyllaceae were below 2% (Table 1).

In May the pollen grains of *Abies*, Cupressaceae, *Picea*, *Pinus, Acer, Aesculus, Betula, Carpinus, Crataegus,* Ericaceae, *Euoynmus, Fagus, Fraxinus, Juglans, Liriodendron, Morus, Platanus, Prunus, Quercus* and *Ulmus* from arboreal taxa; and the pollens of *Carex*, Chenopodiaceae, Cruciferae, *Plantago* and Poaceae from the non-arboreal taxa were identified. In this month, the highest pollen percentage was again found in *Pinus* (30.67%). Other important arboreal taxa that follow *Pinus* in terms of pollen percentage were *Abies* (15.86%), *Picea* (10.36%), *Quercus* (9.54%), *Juglans* (4.1%), Cupressaceae

Table 1. Total pollen count and percentages.

		MARCH		APRIL		MAY	
Arboreal Pollen	**Allergen Level***	**Total**	**%**	**Total**	**%**	**Total**	**%**
Abies	C	0	0	9	0.2	580	15.86
Cupressaceae	B,C	2188	67.24	248	5.61	142	3.88
Picea	-	0	0	40	0.91	379	10.36
Pinus	C	23	0.71	1119	25.32	1122	30.67
Acer	B	0	0	302	6.83	9	0.25
Aesculus	-	0	0	39	0.88	29	0.79
Alnus	A	50	1.54	0	0	0	0
Betula	B	0	0	0	0	7	0.19
Carpinus	-	248	7.62	123	2.78	2	0.05
Corylus	-	30	0.92	0	0	0	0
Crataegus	-	0	0	77	1.74	48	1.31
Ericaceae	-	8	0.25	60	1.36	12	0.33
Euonymus	-	0	0	43	0.97	28	0.77
Fagus	C	0	0	88	1.99	131	3.58
Fraxinus	B, C	387	11.89	42	0.95	49	1.34
Juglans	B	3	0.09	313	7.08	150	4.1
Liriodendron	-	0	0	230	5.2	12	0.33
Morus	B	0	0	411	9.3	105	2.87
Paulownia	-	0	0	20	0.45	0	0
Platanus	B	0	0	360	8.15	30	0.82
Populus	B	2	0.06	0	0	0	0
Prunus	C	0	0	530	11.99	17	0.46
Quercus	A, B	36	1.11	74	1.67	349	9.54
Rosaceae	C	212	6.52	155	3.51	0	0
Salix	C	0	0	26	0.59	0	0
Ulmus	B	60	1.84	17	0.38	1	0.03
Non-Arboreal Pollen							
Apiaceae	B	0	0	2	0.05	30	0.82
Asteraceae	A,B,C	7	0.22	2	0.05	0	0
Campanula	-	0	0	5	0.11	0	0
Cardamine	-	0	0	66	1.49	0	0
Carex	-	0	0	0	0	23	0.63
Caryophyllaceae	-	0	0	18	0.41	0	0
Chenopodiaceae	A	0	0	0	0	2	0.05
Cruciferae	-	0	0	0	0	49	1.34
Plantago	C	0	0	0	0	24	0.66
Poaceae	B, C	0	0	0	0	328	8.97
TOTAL		**3254**	**100**	**4419**	**100**	**3658**	**100**

*A: major importance, B: medium importance, C: minor importance.

(3.88%) and *Fagus* (3.58% cm). Pollen percentage of *Acer*, *Aesculus*, *Betula*, *Carpinus*, *Crataegus*, Ericaceae, *Euonymus*, *Fraxinus*, *Liriodendron*, *Morus*, *Platanus*, *Prunus*, *Ulmus*, Apiaceae, *Carex*, Chenopodiaceae, Cruciferae and *Plantago* were found below 2% (Table 1).

Table 1. Continued.

		JUNE		JULY		AUGUST		SEPTEMBER	
Arboreal Pollen	**Allergen Level**	**Total**	**%**	**Total**	**%**	**Total**	**%**	**Total**	**%**
Abies	C	73	3.96	0	0	0	0	0	0
Cedrus	B	0	0	0	0	2	2.15	7	38.89
Cupressaceae	B, C	32	1.74	2	1.12	0	0	0	0
Picea		9	0.49	0	0	0	0	0	0
Pinus	C	432	23.4	13	7.3	9	9.68	0	0
Castanea	B	16	0.87	11	6.18	0	0	0	0
Craategus		11	0.6	0	0	0	0	0	0
Ericaceae		2	0.11	0	0	0	0	0	0
Fagus	C	1	0.05	0	0	0	0	0	0
Fraxinus	B, C	0	0	0	0	0	0	0	0
Juglans	B	6	0.33	0	0	0	0	0	0
Paulownia		32	1.74	0	0	0	0	0	0
Platanus	B	2	0.11	0	0	0	0	0	0
Quercus	A, B	44	2.39	0	0	0	0	0	0
Rosaceae	C	0	0	2	1.12	40	43.01	0	0
Salix	C	0	0	14	7.87	0	0	0	0
Tilia	C	636	34.5	70	39.33	5	5.38	0	0
Non-Arboreal Pollen									
Apiaceae	B	94	5.1	2	1.12	0	0	0	0
Asteraceae	A, B, C	0	0	28	15.73	24	25.81	6	33.33
Carex	C	2	0.11	0	0	0	0	0	0
Chenopodiaceae	A	11	0.6	5	2.81	9	9.68	2	11.11
Cruciferae		83	4.5	0	0	0	0	0	0
Lamiaceae		7	0.38	0	0	0	0	0	0
Plantago	C	47	2.55	0	0	0	0	0	0
Poaceae	B, C	273	14.8	30	16.85	4	4.3	3	16.67
Urtica	B	31	1.68	1	0.56	0	0	0	0
TOTAL		**1844**	**100**	**178**	**100**	**93**	**100**	**18**	**100**

*A: major importance, B: medium importance, C: minor importance.

In June the pollen grains of *Abies*, Cupressaceae, *Picea, Pinus*, *Castanea*, *Crataegus, Ericaceae, Fagus, Juglans, Paulownia, Platanus, Quercus* and *Tilia* from the arboreal taxa, and the pollens of Apiaceae, *Carex,* Chenopodiaceae, Cruciferae, Lamiaceae, *Plantago*, Poaceae, *Urtica* from the herbaceous taxa were identified. *Tilia* pollens (34.49%) were identified as the densest in June. Other noteworthy arboreal taxa following *Tilia* in terms of pollen percentage were *Pinus* (23.43%), *Abies* (3.96%), *Quercus* (2.39%), along with Poaceae (14.80%), Apiaceae (5.10%), Cruciferae (4.50%) and *Plantago* (2.55%) from the herbaceous taxa. The pollen percentage of Cupressaceae, *Picea, Castanea, Crataegus*, Ericaceae, *Fagus, Juglans, Paulownia, Platanus, Carex,* Chenopodiaceae, Lamiaceae and *Urtica* was found below 2% (Table 1).

In July, the pollen grains of Cupressaceae, *Pinus*, *Castanea*, Rosaceae, *Salix* and *Tilia* from the arboreal taxa, and the pollens of Apiaceae, Asteraceae, Chenopodiaceae, Poaceae, *Urtica* from the herbaceous taxa were detected. *Tilia* pollens (39.33%) were found to be the densest again in July. Other arboreal

taxa following *Tilia* in terms of pollen percentage were *Salix* (7.87%), *Pinus* (7.30%), *Castanea* (6.18%), along with Poaceae (16.85%), Asteraceae (15.73%), and Chenopodiaceae (2.81%) from herbaceous taxa. The pollen percentage of Cupressaceae, Rosaceae, Apiaceae and *Urtica* was found below 2% (Table 1).

In August the pollen grains of *Cedrus*, *Pinus*, Rosaceae, *Tilia* from the arboreal taxa; and of pollens of Asteraceae, Chenopodiaceae and Poaceae from the herbaceous taxa were identified. The pollen of the Rosaceae family (43.01%) was detected as the densest in August. Other arboreal taxa that follow the Rosaceae family in terms of pollen percentage were *Pinus* (9.68%), *Tilia* (5.38%), *Cedrus* (2.15%) along with Asteraceae (25.81%), Chenopodiaceae (9.68%), and Poaceae (4.3%) from herbaceous taxa (Table 1).

In the first week of September, the highest pollen grains belong to *Cedrus* (38.89%) from arboreal taxa was found in the counting process. Among the herbaceous taxa, the highest pollen percentage belonged to the Asteraceae (33.33%) family, followed by the Poaceae (16.67%) and Chenopodiaceae (11.11%) families, respectively (Table 1). The counting process of all preparations was completed and a 25-week (March-September 2020 term) pollen calendar of the Emirgan grove was created (Fig. 2).

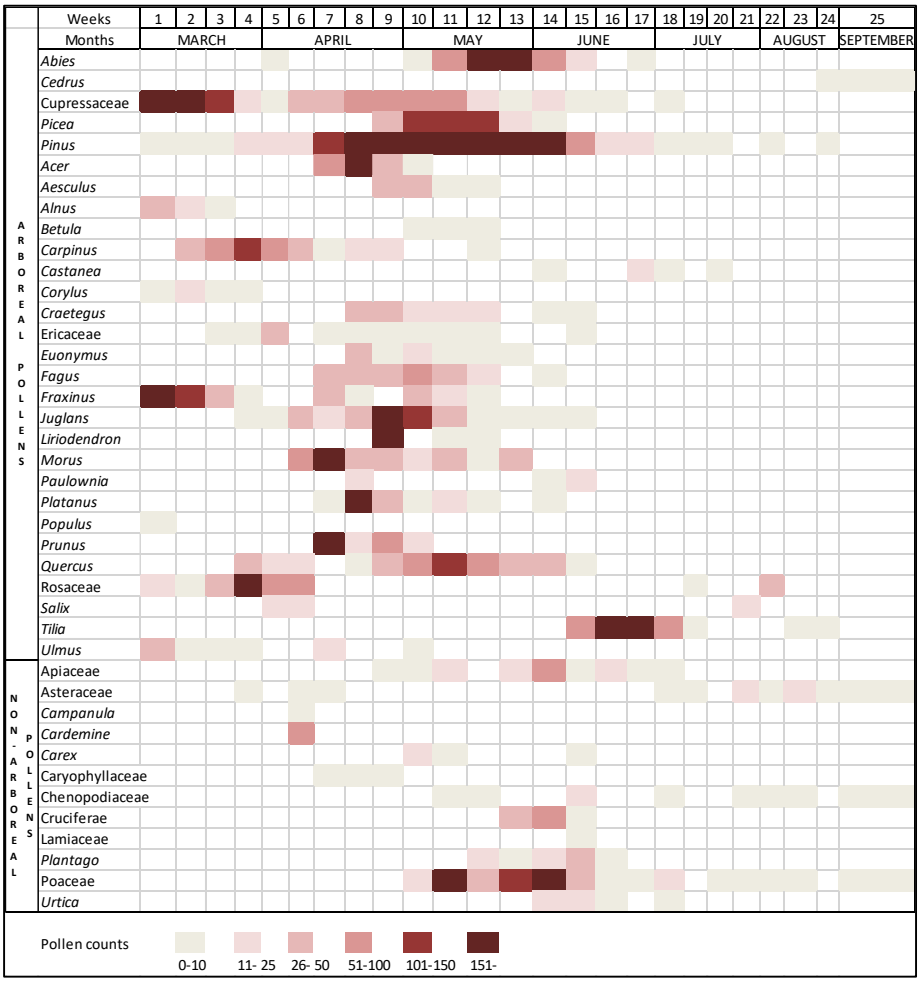

Figure 2**.** Pollen calendar of Emirgan Grove between March-September 2020

Discussion and Conclusion

According to the obtained pollen analysis results, the pollen of 44 taxa including 32 arboreal and 12 non-arboreal taxa were detected, and 90.95% of them were determined to belong to arboreal taxa. Non arboreal taxa were represented with a low percentage in the atmosphere, the increase in pollen percentages started from April and continued until October. (Fig. 2).

The period highest amount of pollen was detected in April. The taxon with the highest pollen density belonged to *Pinus*. In terms of pollen density, *Pinus* was followed by Cupressaceae, *Tilia, Abies,* Poaceae, *Prunus, Morus* and *Quercus* respectively.

According to Celenk et al (2010) carried out pollen monitoring per hour at two points in the European and Asian continents of Istanbul with the Hirst (1952) pollen trap. In this study, April was determined as the month with the highest amount of pollen. Similarly, pollen amount of arboreal taxa was determined as dominant, and Cupressaceae pollen was determined as the taxon with the highest pollen density like our study.

Pollen amount of *Pinus* reaches its highest value in April-May. The allergenic effect of *Pinus* pollen is classified as low-level or non-allergenic (Bıçakçı et al. 2011). The pine tree is among the conifers. The most important feature of these plants is that they are pollinated by the wind and produce amount of pollen. These pollens, which contain two air sacs, can stay in the air longer and can be transported to long distances. Cupressaceae family pollen is the second taxon with the highest pollen density and is found in the atmosphere most densely in March. The pollen of the Cupressaceae family is allergenic (Aytuğ 1974). *Tilia* is the third taxon in terms of pollen density in the atmosphere of the Emirgan grove. The amount of *Tilia*'s pollen reaches its highest value in June. Studies have pointed out that *Tilia* pollen has an allergic effect (Mur et al. 2001). *Quercus* pollen, which is a highly allergenic one, reaches its highest density in May (Aytuğ 1974). The pollen density of the Poaceae, which is a highly allergenic family from herbaceous plant taxa, reaches its highest density in May. The most intense period of *Morus* and *Platanus* pollen, which is highly allergenic, was found in April (Aytuğ 1974, Çetereisi et al. 2019).

The pollen calendar covering the 25-week period (March-September 2020) has been prepared for the Emirgan grove. On the condition that this pollen calendar is shared with the visitors, it will be ensured that the pollen-sensitive guests can visit the grove more healthily. Furthermore, while selecting the new trees to be planted in the grove, plants scattering allergenic pollen should be avoided by considering the pollen calendar created.

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