

# Analysis of airborne pollen fall in Tekirdag, Turkey

## Tekirdağ havasındaki polenlerin analizi

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### ABSTRACT

**Objective:** Airborne pollen grains are important aeroallergens. When released in sufficient amounts, allergenic pollen may evoke allergic responses in the sensitive patients, leading to allergic rhinitis and asthma. The aim of this study was to determine pollen grains and changes in pollen fall per cm<sup>2</sup> weekly, monthly and annually in the atmosphere of Tekirdag.

**Materials and Methods:** In this study, pollen grains were collected from the atmosphere of Tekirdag in 2002 and 2003 using a Durham sampler.

**Results:** During these two years, a total of 7183 pollen grains were recorded. A total of 3462 pollen grains per cm<sup>2</sup> were recorded in 2002 and a total of 3721 pollen grains per cm<sup>2</sup> in 2003. Pollen fall in the years 2002-2003 comprised grains belonging to 45 taxa. Of these taxa, 25 belonged to arboreal and 20 taxa non-arboreal plants. Total pollen grains consisted of 64.08% grains from arboreal plants, 35.89% grains from non-arboreal plants and 0.03% unidentified pollen grains. In the region investigated, *Cupressaceae/Taxaceae* (Cypress/Taxus family), *Pinus* spp. (Pine), *Gramineae* (Grass), *Chenopodiaceae/Amaranthaceae* (Chenopod/Amaranth family), *Quercus* spp. (Oak), *Xanthium* spp. (Cocklebur), *Juglans* spp. (Walnut), *Platanus* spp. (Plane tree),

### ÖZET

**Giriş:** Hava yolu ile yayılan polen tanecikleri önemli allerjenlerdir. Yeterli miktarda salındıklarında duyarlı kişilerde astım ve rinit gelişimine yol açacak şekilde allerjik belirtilere neden olur. Bu çalışmada Tekirdağ atmosferindeki polenlerin belirlenmesi ve haftalık, aylık ve yıllık olarak cm<sup>2</sup>'ye düşen polen sayımının yapılması hedeflenmiştir.

**Gereç ve Yöntem:** Bu çalışmada 2002 ve 2003 yıllarında Tekirdağ atmosferinde polenler Durham cihazı kullanılarak toplanmıştır.

**Bulgular:** İki yıllık süre boyunca cm<sup>2</sup>'de toplam 7183 adet polen kaydedilmiştir. Toplam polen miktarının 3462/cm<sup>2</sup> adedi 2002 yılında, 3721 adedi ise 2003 yılında kaydedilmiştir. 2002-2003 yıllarında 45 taksona ait polen belirlenmiştir. Bunların 25'i odunsu, 20'si ise otsu bitkilere aittir. Toplam polen miktarının %64.08'i odunsu, %35.89'u otsu, %0.03'ü ise tanımlanamayanlara aittir. Araştırma bölgesinde en fazla polen miktarına sahip taksonlar *Cupressaceae/Taxaceae* (servi/porsuk ağacı vb.), *Pinus* spp. (çam ağacı), *Gramineae* (çayır, çimen, tahıl, hububat vb.), *Chenopodiaceae/Amaranthaceae* (akkazayağı/tilkikuyruğu vb.), *Quercus* spp. (meşe ağacı), *Xanthium* spp. (pıtrak), *Juglans* spp. (ceviz ağacı), *Platanus* spp. (çınar ağacı), *Aesculus* spp. (atkestanesi), *Fraxinus* spp. (dişbudak ağacı), *Oleaceae* (zeytin

*Aesculus* spp. (Horse chestnut), *Fraxinus* spp. (Ash), *Oleaceae* (Olive family), *Salix* spp. (Willow), *Plantago* spp. (Plantain), *Rumex* spp. (Sorrel), *Artemisia* spp. (Mugwort) and *Betula* spp. (Birch) released the greatest amounts of pollen. The months of maximum pollen fall was from April to June.

**Conclusion:** The pollen calendar for Tekirdag region presented in this paper may be useful for showing the timing of pollen seasons to visitors to the city, and may be useful for allergologists to establish an exact diagnosis.

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**Key words:** Seasonal, pollen, hypersensitivity

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## INTRODUCTION

Airborne pollen grains are important aero-allergens. When released by sources in sufficient amounts, allergenic pollen may evoke allergic responses in sensitive patients, leading to allergic rhinitis and asthma. The highest risk to sensitized individuals is during the flowering periods of plants<sup>[1]</sup>. Determining the pollen types and their concentration in the atmosphere of highly populated cities is therefore very important. These data prove helpful in the treatment of patients suffering from such diseases. Thus, studies of the pollen content in the atmosphere of different areas have been carried out by researchers. Furthermore, pollen calendars are important for studies in different fields such as phenology, ecology and pollination biology<sup>[1-3]</sup>.

The aim of this study was to determine pollen grains and changes in pollen fall per cm<sup>2</sup> weekly, monthly and annually in the atmosphere of Tekirdag.

## MATERIALS and METHODS

Tekirdag is situated at 42° 34' 52"-40° 52' 53"- 41° 35' 28"- 40° 32' 23" north, 28° 09' 14"-26° 42' 42"-28° 08' 34"-26° 54' 24" east in the northwest of Turkey at an altitude of 25 m above sea level (Figure 1). Tekirdag generally has

ağacı vb), *Salix* spp. (söğüt ağacı), *Plantago* spp. (sınır otu), *Rumex* spp. (kuzukulağı), *Artemisia* spp. (pelin otu) ve *Betula* spp. (puş ağacı)'dir. En fazla polenin görüldüğü aylar nisan-haziran aylarıdır.

**Sonuç:** Bu çalışmada Tekirdağ bölgesinin polen takviminin sunulması şehri ziyarete gelenler için polen mevsiminin zamanını göstermesi açısından ve allerjistler için de doğru tanıyı tanımlaması açısından yararlı olabilir.

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**Anahtar kelimeler:** Mevsimsel, polen, hipersensitivite

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both Mediterranean and Middle European climates. The most frequent winds are from the northeast with an average 3.6 m/sec, an annual mean temperature of 13.8°C, a mean rainfall of 583.3 mm/year, and a mean humidity of 76%.

Vegetation north and east of the city is composed of large-leaved woodland: *Quercus cerris* L. var. *cerris*, *Q. frainetto* Ten, *Q. pubescens* Wild., *Q. robur* L. subsp. *robur*, *Juglans regia* L., *Carpinus betulus* L., and *Tilia tomentosa*. In other regions, the most common trees and shrubs are *Abies bornmüelleriana* Mattf., *Acer regundo* L., *Aesculus hippocastanum* L., *Ailanthus altissima* (Miller) Swingle., *Alnus glutinosa* (L.) Gaertn., *Betula pendula* Roth., *Carpinus orientalis* Miller., *Cornus mas* L., *Corylus avellana* L., *Cupressus sempervirens* L., *Fagus orientalis* L., *Fraxinus ornus* L. subsp. *ornus*, *Morus alba* L., *Pinus nigra* L. subsp. *pallasiana* (Lamb.) Holmboe, *Pinus brutia* Ten., *Picea abies* (L) Karst., *Platanus orientalis* L., *Populus alba* L., *Robinia pseudoacacia* L., *Salix babylonica* L., *S. alba* L., *Sambucus nigra* L., *Taxus baccata* L., *Tilia argentea* Desf. Ex DC, and *Ulmus glabra* Huds.

In addition to the natural vegetation around Tekirdag, the following species are frequently seen in the parks, gardens and streets of the town: *Acacia cyanophylla* Lindley, *Acer regundo* 'Variegatum' L., *Buxus sempervirens* L., *Cedrus li-*

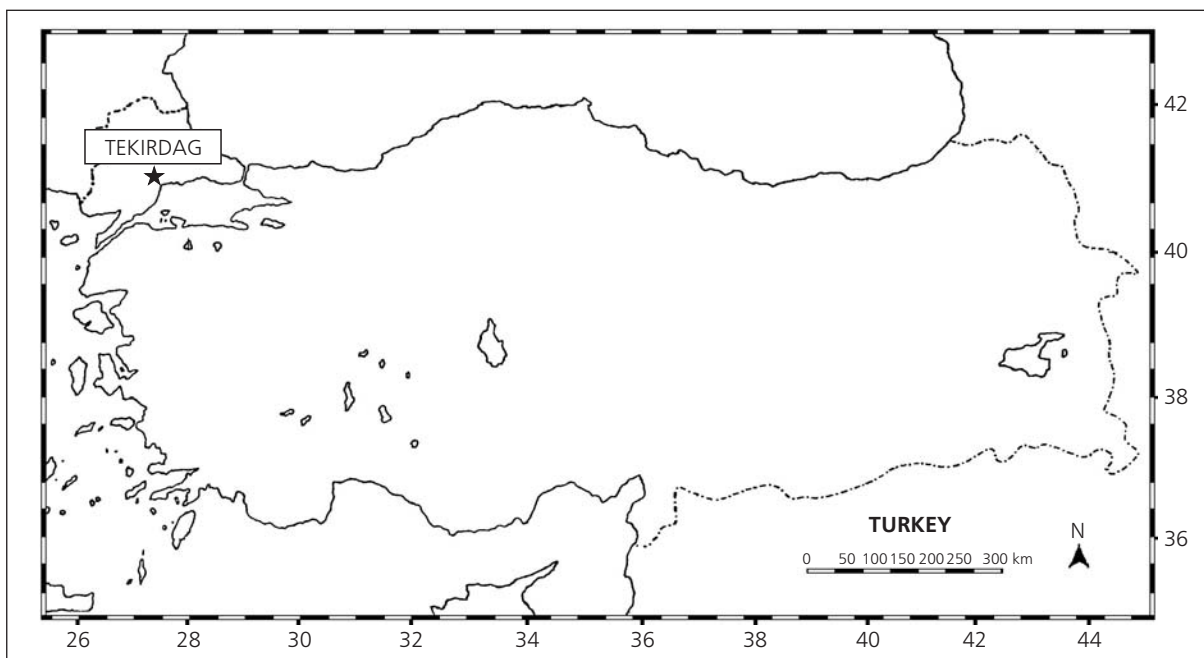


Figure 1. Location of Tekirdag.

*bani* A. Richard., *Cornus alba* L., *Cornus alba sibirica* L., *Cotoneaster nummularia* Fisch et Mey, *Cotoneaster bulata* Boiss., *Cupressus macrocarpa* Hartw. 'Goldcrest', *Cupressus sempervirens* L. var. *horizontalis* L., *Cupressus arizonica* Grene., *Forsythia intermedia*, *Juniperus sabina* L., *J. oxycedrus* L., *J. communis* L. ssp. *hemispherica* (Pres) Nyman, *J. communis* L. ssp. *alpina* (Sm.) Celak, Syme, *Laurus nobilis* L., *Pinus brutia* Ten., *Pinus pinea* L., *Platanus orientalis* L., *Populus* spp., *Prunus pissardii* Carr. 'Nigra', *Pyracantha coccinea* Roemer., *Robinia pseudoacacia* L., *Thuja orientalis* L., *T. occidentalis* L., and *Viburnum opulus* L.

In this study, a Durham apparatus was used. The apparatus was located at 10 m height above ground level. The slides were mounted and stained in glycerine jelly mixed with basic fuchsin and examined under light microscope weekly. The grains were identified to a minimum of family level and to genus level in most cases. Grains that could not be identified were recorded as unidentified types. The number of pollen grains was expressed as grains per square centimeter of microscope cover glass (22 mm x 22 mm)<sup>[4]</sup>.

## RESULTS

The total pollen concentration registered during the sampling period was 7183 grains/cm<sup>2</sup>-3462 pollen grains in 2002 and 3721 pollen grains in 2003. The counts included over 45 different pollen types (25 arboreal plants [AP] and 20 non-arboreal plants [NAP]). A total of 4603 pollen grains were determined as AP (64.08%), 2578 as NAP (35.89%), and 2 as unidentified pollen grains (0.03%) (Table 1).

The most pollen recorded in the atmosphere of Tekirdag was from APs: Cupressaceae/Taxaceae (19.67%), *Pinus* spp. (15.90%), *Quercus* spp. (5.72%), *Juglans* spp. (3.72%), *Platanus* spp. (3.36%), *Aesculus* spp. (2.64%), *Fraxinus* spp. (1.72%), Oleaceae (1.60%), *Salix* spp. (1.44%), and *Betula* spp. (1.01%). They formed 56.78% of the total pollen fall (Table 1, Figure 2).

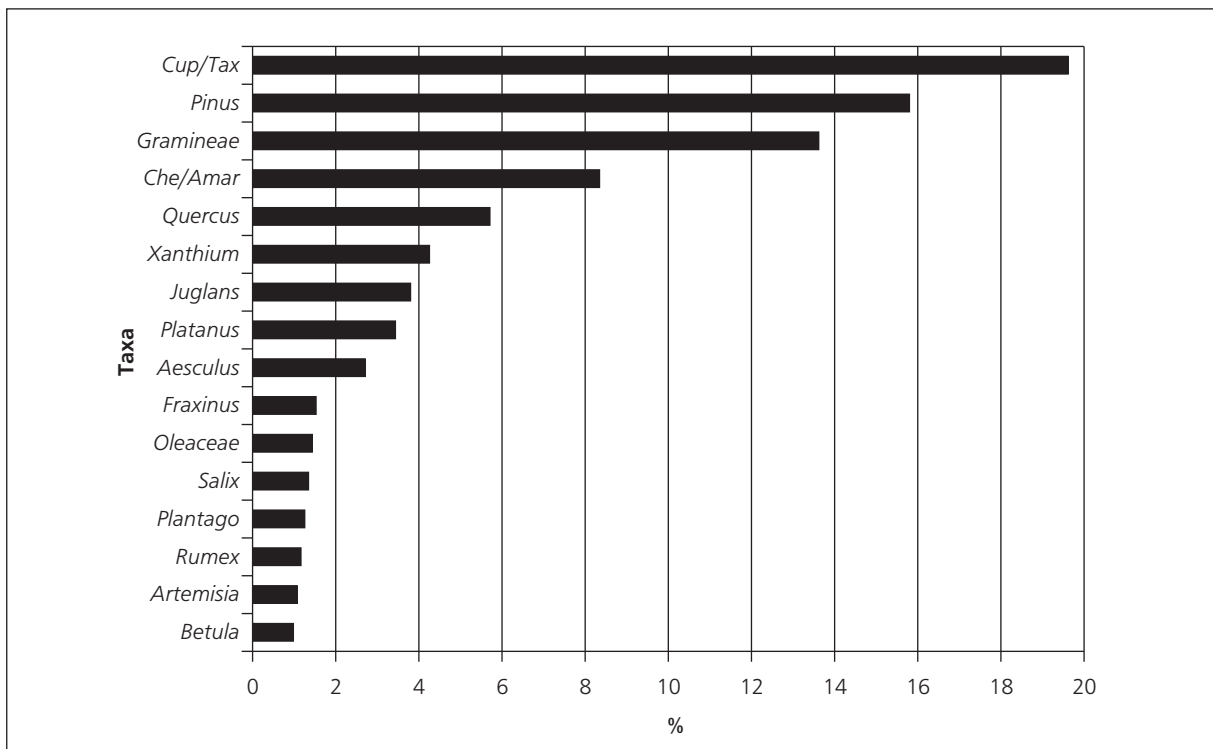
Of the herbaceous plants, Gramineae (13.70%), Chenopodiaceae/Amaranthaceae (8.32%), *Xanthium* spp. (4.25%), *Plantago* spp. (1.32%), *Rumex* spp. (1.11%), and *Artemisia* spp. (1.08%) were found frequently in the atmosphere of Tekirdag, making up 29.78% of the total (Table 1, Figure 2).

**Table 1. Annual percentages of pollen counts for Tekirdag, 2002-2003**

	2002		2003		2002-2003	
	Total	%	Total	%	Total	%
<i>Cup/Tax</i>	753	21.75	661	17.76	1414	19.69
<i>Pinus</i>	538	15.54	605	16.26	1143	15.91
<i>Quercus</i>	135	3.90	276	7.42	411	5.72
<i>Juglans</i>	75	2.17	192	5.16	267	3.72
<i>Platanus</i>	81	2.34	161	4.33	242	3.37
<i>Aesculus</i>	79	2.28	111	2.98	190	2.65
<i>Fraxinus</i>	69	1.99	55	1.48	124	1.73
<i>Oleaceae</i>	53	1.53	62	1.67	115	1.60
<i>Salix</i>	72	2.08	32	0.86	104	1.45
<i>Betula</i>	13	0.38	60	1.61	73	1.02
<i>Carpinus</i>	13	0.38	57	1.53	70	0.97
<i>Morus</i>	31	0.90	23	0.62	54	0.75
<i>Ailanthus</i>	24	0.69	26	0.70	50	0.70
<i>Fagus</i>	20	0.58	29	0.78	49	0.68
<i>Corylus</i>	19	0.55	25	0.67	44	0.61
<i>Populus</i>	22	0.64	19	0.51	41	0.57
<i>Alnus</i>	9	0.26	30	0.81	39	0.54
<i>Ostrya</i>	9	0.26	30	0.81	39	0.54
<i>Ulmus</i>	8	0.23	24	0.64	32	0.45
<i>Robinia</i>	21	0.61	9	0.24	30	0.42
<i>Tilia</i>	3	0.09	16	0.43	19	0.26
<i>Acer</i>	15	0.43	1	0.03	16	0.22
<i>Cedrus</i>	6	0.17	9	0.24	15	0.21
<i>Ericaceae</i>	8	0.23	4	0.11	12	0.17
<i>Rosaceae</i>	9	0.26	1	0.03	10	0.14
AP Total	2085	60.23	2518	67.67	4603	64.08
<i>Gramineae</i>	470	13.58	515	13.84	985	13.71
<i>Che/Amar</i>	357	10.31	241	6.48	598	8.33
<i>Xanthium</i>	227	6.56	79	2.12	306	4.26
<i>Plantago</i>	49	1.42	46	1.24	95	1.32
<i>Rumex</i>	30	0.87	50	1.34	80	1.11
<i>Artemisia</i>	34	0.98	45	1.21	79	1.10
<i>Urticaceae</i>	39	1.13	30	0.81	69	0.96
<i>Compositae</i>	29	0.84	37	0.99	66	0.92
<i>Helianthus</i>	34	0.98	30	0.81	64	0.89
<i>Umbelliferae</i>	21	0.61	27	0.73	48	0.67
<i>Humulus</i>	9	0.26	29	0.78	38	0.53
<i>Cruciferae</i>	19	0.55	16	0.43	35	0.49
<i>Leguminosae</i>	10	0.29	20	0.54	30	0.42
<i>Carex</i>	8	0.23	14	0.38	22	0.31

**Table 1. Annual percentages of pollen counts for Tekirdag, 2002-2003 (continued)**

	2002		2003		2002-2003	
	Total	%	Total	%	Total	%
<i>Typha</i>	13	0.38	9	0.24	22	0.31
<i>Taraxacum</i>	12	0.35	9	0.24	21	0.29
<i>Centaurea</i>	7	0.20	-	0.00	7	0.10
<i>Rubiaceae</i>	1	0.03	5	0.13	6	0.08
<i>Luzula</i>	4	0.12	-	0.00	4	0.06
<i>Labiatae</i>	2	0.06	1	0.03	3	0.04
NAP Total	1375	39.72	1203	32.33	2578	35.89
Unidentified	2	0.06	-	0.00	2	0.03
<b>TOTAL</b>	<b>3462</b>	<b>100.00</b>	<b>3721</b>	<b>100.00</b>	<b>7183</b>	<b>100.00</b>

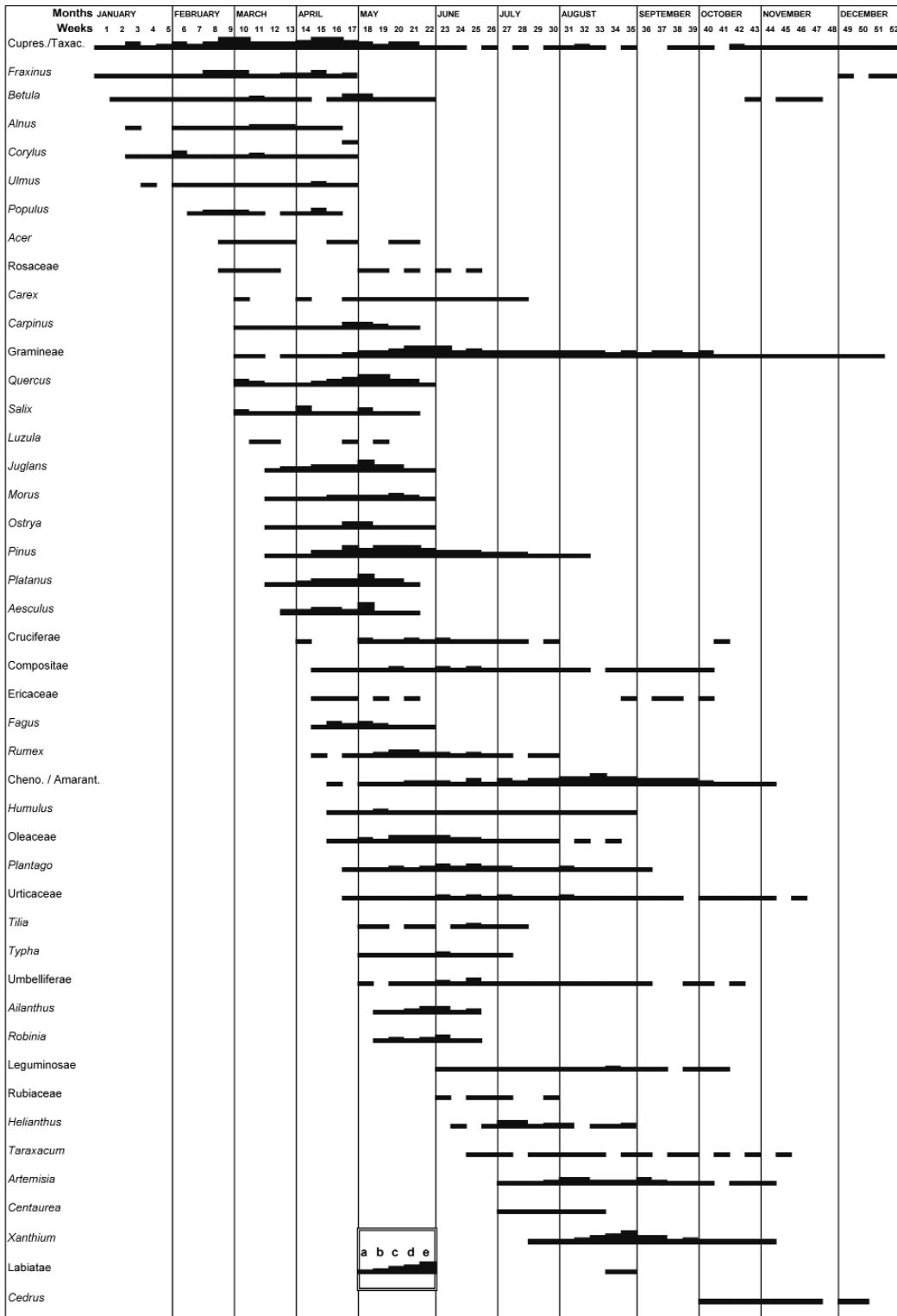


**Figure 2. Total biannual percentage values of the main pollen types in the atmosphere of Tekirdag.**

The types of pollens present in the atmosphere of Tekirdag are shown in the form of a pollen calendar based on the counts made in 2002-2003 (Figure 3).

The general trend showed an increase in pollen counts from spring to summer, reaching

a maximum level in May. 63.93% of total pollen grains appeared from April to June (Figure 4). In the late summer, pollen concentrations start to decrease due to the scarcity of flowering plants. The very small number of grains observed from autumn until early spring was notable (Figure 4).



a; 1-4      b; 5-9      c; 10-49      d; 50-99      e; 100>

Figure 3. Pollen calendar for Tekirdag (2002-2003).

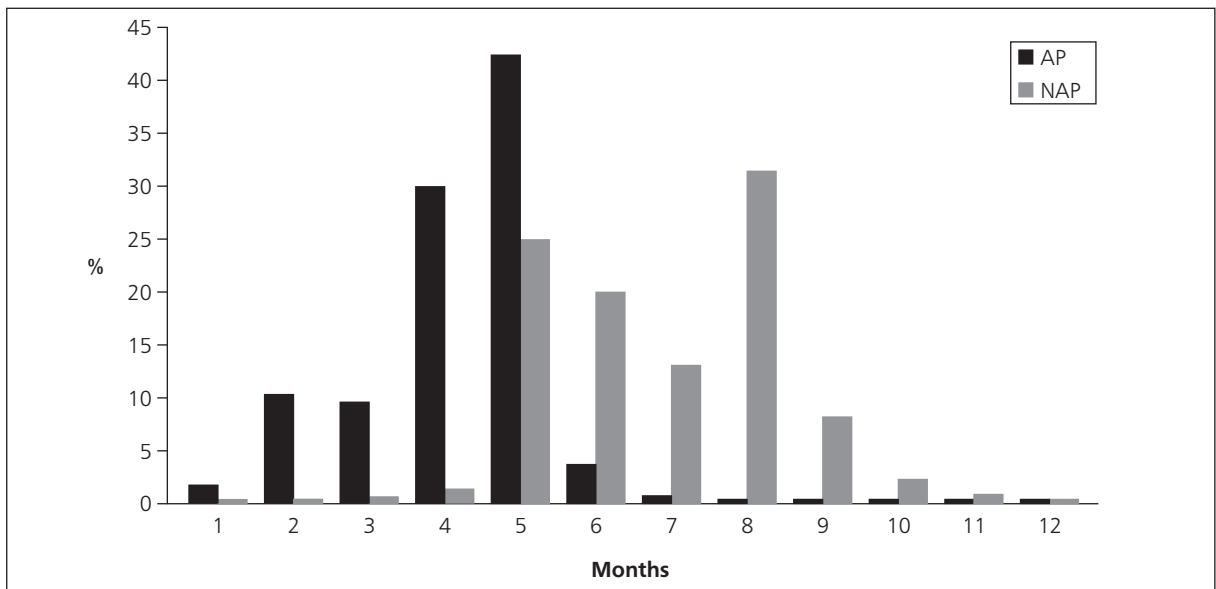


Figure 4. Monthly total variations in arboreal (AP) and non-arboreal (NAP) pollen grains in the atmosphere of Tekirdag (2002-2003).

The following taxa (16 taxa) produced the greatest amounts of pollens in the atmosphere of Tekirdag (Table 1, Figure 2):

**Cupressaceae/Taxaceae** Pollen production was continued from the first week of January and recorded year round. Maximum amounts were determined in the fourth week of February (9<sup>th</sup> week). The highest values were noted between the 9<sup>th</sup> and 16<sup>th</sup> weeks. The total number was 753 (21.75%) in 2002 and 661 (17.76%) in 2003.

**Pinus** Pollen season started in the third week of March (12<sup>th</sup> week) to the second week of August (32<sup>nd</sup> week). The highest values were noted between the 17<sup>th</sup> and 22<sup>nd</sup> weeks. The total number was 538 (15.5%) in 2002 and 605 (16.25%) in 2003.

**Gramineae** Pollen season started in the first week of March (10<sup>th</sup> week). The highest count was recorded between the 21<sup>st</sup> and 23<sup>rd</sup> weeks. The total number was 470 (13.57%) in 2002 and 515 (13.84%) in 2003.

**Chenopodiaceae/Amaranthaceae** Pollen production was continued from the third week of April (16<sup>th</sup> week) to the first week of November (44<sup>th</sup> week). The highest values were noted

between the 31<sup>st</sup> and 35<sup>th</sup> weeks. The total number was 357 (10.31%) in 2002 and 241 (6.47%) in 2003.

**Quercus spp.** Pollen production was continued from the first week of March to the last week of May (22<sup>nd</sup> week). The highest count was recorded between the 18<sup>th</sup> and 19<sup>th</sup> weeks. The total number was 135 (3.89%) in 2002 and 276 (7.41%) in 2003.

**Xanthium spp.** Pollen season started in the third week of July (29<sup>th</sup> week) and ended in the first week of November. The highest values were noted between 33<sup>rd</sup> and 37<sup>th</sup> weeks. The total number was 227 (6.55%) in 2002 and 79 (2.12%) in 2003.

**Juglans spp.** Pollen season started in the third week of March and ended in the last week of May. The highest count was recorded in the 18<sup>th</sup> week. The total number was 75 (2.19%) in 2002 and 192 (5.16%) in 2003.

**Platanus spp.** Pollen production was continued from the third week of March to the fourth week of May (21<sup>st</sup> week). The highest count was recorded in the 18<sup>th</sup> week. The total number was 81 (2.34%) in 2002 and 161 (4.32%) in 2003.

**Aesculus spp.** Pollen season started in the last week of march (13<sup>th</sup> week) and ended in the fourth week of may. The highest count was recorded in the 18<sup>th</sup> week. The total number was 79 (2.28%) in 2002 and 111 (2.98%) in 2003.

**Fraxinus spp.** Pollen production was continued from the first week of the year to the last week of april (17<sup>th</sup> week). The highest values were noted 8<sup>th</sup> week and 10<sup>th</sup> week, between the 15<sup>th</sup> week of the year. The total number was 69 (1.99%) in 2002 and 55 (1.48%) in 2003.

**Oleaceae** Pollen season started in the third week of april and ended in the fourth week of august (34<sup>th</sup> week). The highest values were recorded in the 20<sup>th</sup> and 23<sup>rd</sup> weeks. The total number was 53 (1.53%) in 2002 and 62 (1.66%) in 2003.

**Salix spp.** Pollen production was continued from the first week of march to the fourth week of may. The highest values were noted in the first week of april (14<sup>th</sup> week) and first week of may (18<sup>th</sup> week). The total number was 72 (2.08%) in 2002 and 32 (0.86%) in 2003.

**Plantago spp.** Pollen season started in the last week of april and ended in the first week of september (36<sup>th</sup> week). The highest count was recorded in the 20<sup>th</sup> and 27<sup>th</sup> weeks of the year. The total number was 49 (1.41%) in 2002 and 46 (1.23%) in 2003.

**Rumex spp.** Pollen season started in the second week of april (15<sup>th</sup> week) and ended in the last week of july (30<sup>th</sup> week). The highest values were noted between the 20<sup>th</sup> and 21<sup>st</sup> weeks. The total number was 30 (0.86%) in 2002 and 50 (1.34%) in 2003.

**Artemisia spp.** Pollen production was continued from the first week of july (27<sup>th</sup> week) to the first week of november. The highest counts were recorded between the 30<sup>th</sup> and the 37<sup>th</sup> weeks. The total number was 34 (0.98%) in 2002 and 45 (1.21%) in 2003.

**Betula spp.** Pollen season started in the second week of january and ended in the last week of may (22<sup>nd</sup> week). The highest values were noted between the 17<sup>th</sup> and 18<sup>th</sup> weeks. The total number was 13 (0.37%) in 2002 and 60 (1.73%) in 2003.

## DISCUSSION

In the atmosphere of Tekirdag, arboreal pollen types were dominant. The frequency of arboreal pollen grains generally depends on the distribution and density of the local vegetation and rate of pollen production. According to the other studies carried out in Europe and in many countries, arboreal pollen types are also dominant in Finland (82%), Bursa, Turkey (78.61%), Burdur, Turkey (76.1%), Edirne, Turkey (71.81%), Perugia (71%) and Ascoli Piceno (55%), Balikesir, Turkey (70.92%), Afyon, Turkey (69.67%), Allahabad, India (66.77%) and Sakarya, Turkey (69.45%)<sup>[5-13]</sup>.

Variations in the amount of pollen recorded from different taxa can be seen in the pollen calendar that was prepared from average values of the pollen counts (Figure 3). Sixteen plant taxa were found to have more than 1% of the total pollen content, and five of them (*Cupressaceae/Taxaceae*, *Pinus* spp., *Gramineae*, *Chenopodiaceae/Amaranthaceae* and *Quercus* spp.) were up to 5% of the total. *Cupressaceae/Taxaceae* were the most frequently recorded pollen grains (19.67%) in the study region. This result showed similarity with the other studies prepared in the Mediterranean region, such as: Burdur (27.82%), Mexico (13%), Samobor (12.4%) and Zagreb (8.6%), Sakarya (10.31%), and Edirne (8.75%)<sup>[7,8,13-15]</sup>. *Cupressaceae/Taxaceae* pollen grains were seen nearly the whole year. In Turkey, *Cupressaceae/Taxaceae* (or *Cupressaceae-Cupressus* type) pollen grains were recorded from all localities as a dominant and also in Italy and Greece from the Mediterranean region<sup>[7,10,11,16,17]</sup>.

Most of the dominating pollen grains in Tekirdag atmosphere have been reported as being important allergens. However, pollen grains belonging to *Pinaceae* family are generally considered to be of a low allergenic risk<sup>[18-20]</sup>. We recorded high levels of important allergenic pollen grains such as: *Cupressaceae/Taxaceae*, *Morus* spp., *Olea* spp., *Platanus* spp., *Quercus* spp., *Fraxinus* spp., and *Plantago* spp.<sup>[5,20-25]</sup>. *Gramineae* (grass) pollen is a major cause of pollinosis in



many parts of the world, and grass-induced pollinosis is also the most common pollen allergy in the Mediterranean area<sup>[26,27]</sup>.

In conclusion, pollen grains of 45 taxa were identified during 2002-2003 in the atmosphere of Tekirdag, of which 16 formed about 86.56% of the total pollen spectrum. The pollen grains investigated in the region reached their maximum level from april to june. The pollen calendar for the region presented in this paper may be useful for showing the timing of pollen seasons of visitors to the city, and may be useful for allergologists to establish an exact diagnosis.

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